UNIVERSITY OF BRISTOL.

THE ANNUAL REPORT

OF THE

Agricultural and Horticultural Research Station

(THE NATIONAL FRUIT AND CIDER INSTITUTE)

LONG ASHTON, BRISTOL,

1928.

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INTRODUCTION.

The following Report, although principally concerned with that part of the work of the Agricultural and Horticultural Department of the University of Bristol carried on at the Long Ashton Research Station, (The National Fruit and Cider Institute), covers also the advisory section of the work of the two other centres of the Department, viz. the Berkeley Square Agricultural Advisory Centre and the Campden Research Station. This course makes it possible to show the varied nature and the extent of the service now being rendered to agriculture and horticulture, more particularly in the West of England, by the Department, the existence of which is the result of the original action of the Bath and West Society leading to the establishment of the Institute.

The individual contributions of members of the research and advisory staffs to the Report are recorded in the table of contents appended. The results achieved have been due also in no small measure to the help given in various ways by the other members of all grades of the staff of the Department. Their assistance in their respective spheres of work deserves special recognition and appreciation.

Long Ashton Research Station.

In reviewing the events and developments of 1928 at the Station, two features in particular stand out to make the year notable in its history. These are the visits paid by both the Minister of Agriculture, the Rt. Hon. Walter E. Guinness, M.P., D.S.O., and the Parliamentary Secretary of the Ministry, the Rt. Hon. the Earl of Stradbroke, K.C.M.G., C.B., and the completion of the new laboratory building. A more detailed reference is made to them later.

In other respects, while the year has not been marked by any outstanding developments, the general progress of the work has been steadily maintained and evidence of the increasing notice which it is attracting among those whom the work concerns in this country and overseas has been constantly forthcoming. The additional accommodation now available as the result of the extension of the laboratory building has made it possible to carry on the research work under greatly improved working conditions

and also to provide more satisfactory facilities for the reception of parties of visitors. The number of the latter has reached a point beyond which under existing arrangements it may be unsafe to go in the interests of the work, the consequent heavy call on the time of certain of the members of the staff necessarily falling at a season of the year when their investigations demand their full attention.

Fortunately staff changes during the year have been fewer than of recent years. This and the passing of other factors which rendered normal work so difficult in the preceding year have assisted also in making working conditions more favourable. The opportunity thus given has been well utilised, as future publications are likely to show.

The extension of the work on the nutrition of fruit trees and its relation to fruit quality made possible as the result of a special grant from the Empire Marketing Board, referred to in last year's Report, is now well in hand. With the aid of the new knowledge being gained through these investigations the fruit grower should be in a position before long to control the quality of his fruit to a degree not previously attained.

Staff. The only member of the regular scientific staff of the Station who has left during the year is Dr. R. M. Nattrass, the Adviser in Economic Mycology. He has accepted a similar appointment under the Egyptian Government, and has been succeeded by Mr. L. Ogilvie, M.A., M.Sc. The latter, whose special mycological training has been received at Aberdeen and Cambridge Universities, returns to this country after some years' service as Government Mycologist in Bermuda, where he was occupied largely with investigations on virus diseases.

Under the Empire Marketing Board scheme of research on fruit quality, Miss U. Tetley, M.Sc., has completed the twelve months' period of study on the developmental anatomy of the apple for which she was appointed. Her work on this question and other lines of investigation arising from it have been taken over by Dr. J. C. Hinton, who has been appointed Plant Physiologist under the scheme. Dr. Hinton comes from the University of Leeds, where he received his botanical training under Professor J. H. Priestley. As a pupil of the latter, whose close association with the Long Ashton work has been previously reported, he starts with the advantage of some previous acquaintance with the problems upon which he is now engaged.

The Bathurst Studentship awarded by Newnham College, Cambridge, to Miss Katharine Johnstone for post-graduate research

has been extended for a second year. Miss Johnstone is enabled accordingly to continue for another season the investigations on Apple Scab which she began in August, 1927.

Miss T. Van IJzeren, from the Landbouwhoogeschool te Wageningen, Holland, spent the months of July and August at the Institute. Her visit, arranged at the request of Professor Sprenger, under whom she is working at the Dutch Station, was occupied chiefly by a general study of the investigations in progress at Long Ashton.

By arrangement with the Professors of Chemistry and Physics of the University of Bristol, Mr. J. E. Williams, a student in their Departments, is assisting for one year the chemical staff at the Institute engaged on soil and nutrition problems.

Land and Plantations. The rate of extension of field experiments on fruit culture at Long Ashton itself has been reduced greatly, partly for financial reasons and partly owing to lack of suitable land belonging to the Station. Little new work of this character can be undertaken there in future on any considerable scale, except on plots already occupied by experiments, as these become available when no longer required for their present purposes. Since almost the whole of such land has been planted up comparatively recently, there is little prospect of being able to keep pace with the requirements for fresh field trials arising from research work already in progress, unless means are found to acquire additional land in the neighbourhood.

It has been necessary, therefore, to take into consideration the policy of supplementing the field work at Long Ashton by carrying out extension field trials in growers' plantations and other suitable places elsewhere. Only certain lines of work lend themselves to this course, and in any case there are many difficulties attached. Where, however, reasonably satisfactory arrangements can be made, the system is being given a trial in the hope that by degrees more land at the Station will be freed thus for the class of work which can only be done on the spot.

A policy of this kind is not entirely new in the history of the Institute. The trial cider orchard scheme, which has been in operation for many years, represents a case in point. Similarly, some of the spraying and manurial trials of recent years have been arranged at outside centres. In all these cases, however, the work has been conducted outside the Institute because of the need of carrying out trials under conditions or on materials which Long Ashton did not provide. The type of case under consideration now differs in that the use of an outside centre is imposed by lack of land only, and not by unsuitable conditions otherwise.

The outstanding case of this kind which confronts the Station at the moment is that of the provision of adequate trials of the selections of seedling or "free" and "crab" apple stocks which Mr. Spinks has made as the result of his investigations on this subject over many years. These selections are now being propagated in sufficient quantity to permit of thorough trial. The majority having been selected with the object of discovering a stock of vigorous and hardy character suited for the production of standard trees and capable of being propagated vegetatively, it follows that the trials must be carried out mainly on trees grown in the form of standards. Hence the acreage involved is necessarily very large, even when the number of trees of the same kind used in the tests is reduced to a figure which may be inadequate to furnish significant statistical results. The 12-acre plot in preparation for the Long Ashton trial referred to in the last Annual Report was planted up in the Autumn of 1928. Two small supplementary plots, at Eardiston, Worcestershire, and Pitminster, Somerset, respectively, were started simultaneously. The two latter will serve in some measure to strengthen the statistical aspect of the trials and should afford a useful comparison of the behaviour of the tested stocks under different local conditions. If satisfactory arrangements can be made, it is intended to proceed with the establishment of additional trial orchards at other centres each year until the series of tests is sufficiently complete to allow a sound judgment on the merits of the tested stocks to be formed.

The only other planting of any tree fruits, except seedlings, at the Institute during the year has been that of a fresh set of apple trees of the Lane's Prince Albert variety worked on some of the stocks referred to in the previous paragraph and grown in bush form. This set replaces a corresponding group planted in the winter of 1925-6 on a plot of land previously old pasture. The irregular growth of the first set indicated clearly the existence of certain soil difficulties affecting nutrition. Suitable treatment has been applied to the land and it is expected that the fresh batch of trees will not suffer as their predecessors.

With reference to soft fruits, a 1 acre plot of strawberries was planted in August for the purpose of further investigations of the problems of this crop upon which the Station has been engaged during recent years.

Plots of seedling black currants of particular promise selected from the varieties bred at the Station have been established on a scale suitable for cropping trials and other observations on the merits of the individual seedlings.

Similarly selected raspberry seedlings have been added to the

previously established raspberry variety trials. Additions of other varieties obtained from outside sources have also been made.

The already large collections of seedling varieties of the various hardy fruits raised in the course of the fruit breeding investigations have been extended by the addition of the latest batch of seedlings. On the other hand, it has been possible to reduce considerably the number under trial, those which have fruited sufficiently frequently to permit of a decision as to their promise having been discarded except in cases where further trial is merited. The collection of apple seedlings in particular has been weeded out extensively in this way.

A few additions to the collection of willow varieties has been made and several new seedlings raised at the Station have been planted out on trial.

Buildings. The fittings of the laboratory extension built in 1927 have been installed and the additional accommodation thus available is now in full use. The new wing and the other buildings mentioned in the next paragraph were publicly opened on July 4th by the Rt. Hon. Walter E. Guinness, M.P., D.S.O., Minister of Agriculture. He was accompanied by Sir Chas. Howell Thomas, C.M.G., Permanent Secretary of the Ministry, and other members of the staff of the Ministry. The Empire Marketing Board, whose grant covered the cost of the accessory buildings and fittings and a part of the laboratory extension, was represented by Mr. S. G. Tallents, Secretary of the Board. The attendance, which had to be restricted to 250 on account of the limited accommodation available, was representative of all interests connected with the Station, including the City and University of Bristol, the Bath and West Society, the respective County Councils contributing annual grants to the Institute and the National Farmers' Union. Particularly gratifying to all concerned was the presence of Mr. R. Neville Grenville, J.P., who with the support of the Bath and West Society was the first in the country to carry out organised experiments on cider making and whose pioneer work resulted in the establishment of the Institute.

The principal buildings and other structures required for the new work under the Empire Marketing Board scheme have been erected during the year, with the exception of the ordinary temperature fruit store, which was provided in advance in 1927, as described in the Report for that year, to serve for the 1927-8 season storage tests. For the tests on storage quality this store is now supplemented by a new cold Store, in which the fruit can be held at a constant low temperature and practically constant humidity. It

has been designed upon lines specially applicable to growers' conditions and represents on a small scale a commercial fruit cold store constructed to embody the most recent ideas on low temperature storage.

The facilities for pot culture investigations have required considerable extension for that side of the work under the same scheme. There has been erected a new greenhouse 100 feet x 40 feet, with special arrangements for extensive ventilation so that trees in pots can be grown in it throughout the season under practically open air conditions, except that protection from rain is provided. In it can be stored in addition during the winter months all the remaining trees in pots upon which experiments are being carried out under the scheme : these are kept in the open during the growing season in a large wired enclosure adjacent to the greenhouse, also built at the same time.

General. This year the Annual Tasting Day on the first Thursday in May, the standing date, again set up a new record for attendance. This was estimated at approximately 1,100. Among the visitors was the Parliamentary Secretary for Agriculture, the Rt. Hon. the Earl of Stradbroke, K.C.M.G., C.B., who gave a short address during the course of the day and distributed the prizes to the winners in the third Annual Cider Competitions. The entries in the Competitions were set out for sampling on the occasion, as in previous years, and attracted much attention. The remarkable increase in the number —which was 180 and easily a new record— speaks for itself as to the manner in which this scheme is appreciated and the practical results in the direction of improvement of farm orcharding and the supply and quality of cider fruit which may be reasonably expected to follow.

Following the innovation of the previous year, the adjourned annual meetings of the Governors and Members of the National Fruit and Cider Institute were held at the Station in mid-summer, to give those attending an opportunity of seeing features of the work at a different stage from those occurring at the time of the usual other Annual Functions arranged at Long Ashton. The actual date was June 29th. It is recognised that any date about that period must be inconvenient for many members on account of pressure of other work : but, since the attendance fell below what had been expected, some doubt has been raised as to the utility of a meeting at that time of year. The arrangement for a meeting at that season having been decided upon solely for the benefit of members, and necessarily interfering with the work of the staff concerned at a particularly busy period, some alteration may be desirable if a better attendance is not secured.

The number of organised parties visiting the Institute during the year was rather smaller than usual, chiefly owing to a reduction of the Saturday afternoon parties of a local character from Bristol and its immediate neighbourhood. On the other hand in the case of the first three shown in the complete list appended, the visits were in the nature of Conferences and extended into a second day in each instance :—

Association of Economic Biologists.
The Joint Committee of the Provincial Advisory Conference of the Harper Adams and Bristol Provinces.
The Staff of the East Malling Research Station.
Hereford Branch of the National Farmer's Union.
Western Centre of the Institution of Electrical Engineers.
South Western Naturalists' Union.
"Times and Mirror" (Uncle Jack's party).
Cornish party organised by Mr. H. W. Abbiss, Horticultural Superintendent for Cornwall.
Bristol Post Office Retired Officers' Association.
Gloucestershire Root, Fruit and Grain Society.
Portishead & District Allotment Association, Ltd.

The visit of the party of the Association of Economic Biologists was arranged originally for 1926 and abandoned then on account of the general strike. The members attending the Conference formed a very representative group of the leading workers on plant pathology in this country, among them being Messrs. C. T. Gimingham and S. P. Wiltshire, who, as old members of the Long Ashton staff, were especially welcomed.

The joint meeting of the members of the Advisory Conferences of the Harper Adams and Bristol Provinces is an annual function, taking place alternately at suitable centres in the respective Provinces. It provides an excellent opportunity for the discussion and arrangement of joint experimental work in agriculture and horticulture over a wide area of the west-midland and western districts of this country. The gathering was very representative and, as usual, served a highly useful purpose.

Similarly the joint meeting of the staffs of the East Malling and Long Ashton Research Stations is now a regular fixture, held alternately at each place. It enables the respective programmes of work of the two Stations to be discussed by the individuals concerned and facilitates the planning of conjoint investigations and the avoidance of unnecessary overlapping. Special importance was attached to this occasion on account of the new schemes of work which both Stations are now undertaking for the Empire Marketing Board.

Educational exhibits illustrating the work of the Station were sent to several Shows during the course of the year. In the first

three cases mentioned in the appended list they covered the work of the whole of the Agricultural and Horticultural Department.

Bath & West Show, Dorchester.
Three Counties Show, Hereford.
Wiltshire Show, Salisbury.
Brewers' Exhibition, London.
Devon County Agricultural Show, Plymouth.
Tamar Valley Horticultural Spring Show, Plymouth.
Bedwelty Show, Blackwood, Mon.
Abergavenny Horse Show, Abergavenny.
Melplash Agricultural Society's Show, Bridport, Dorset.
Wimborne and Blandford Show, Wimborne, Dorset.

Requests for lectures by members of the Staff have continued to be numerous and have not been confined to the Bristol Province. It has not been possible to accept all invitations, the amount of time which can be spared for extra-mural work of this kind being necessarily limited. Since, however, such lectures dealing with some aspect or other of the Station's research work afford a means of bringing the work directly before growers and others most closely interested, and since first-hand touch is also established through them with the special problems of the districts visited, as many invitations have been accepted as circumstances permitted.

Although efforts are made by means of field days and the reception of visitors on other occasions at the Institute, show exhibits, lectures, publications and other forms of publicity, to convey to the fruit grower the results of the research work, it is clear that a further link with the growers is necessary if full advantage is to be taken of the practical applications of that work. The details of such application generally can only be settled in the case of the individual grower by a visit to his plantations to see the conditions on the spot. The desire of growers for such visits is constantly growing, but the research worker can spare little time from his working centre for work of this kind, which, strictly speaking, is advisory in character. Although the Bristol Province is provided with advisers on the pathological and chemical sides, there is no existing provision for advisory work in pomological science. Until an adviser in that subject can be appointed, the link with the grower can only be strengthened at the expense of the research work.

Very gratifying progress in respect of the work of the Station on cider-making can be reported. There is a great demand for the services of the Instructor in Cider Making, Mr. P. T. H. Pickford, in the three counties which come within the Cider Instruction Scheme. His work is dealt with further elsewhere in this Report, as is also the Cider Competition Scheme, which has developed to an extent which now taxes the resources of the Station in this subject

to the utmost and is restricting research and experimental work. The task which the three judges in these Competitions, Messrs. J. W. Pullin, S. Weston and R. L. Roach, had to face on this occasion was exceptionally heavy, and the indebtedness of the Institute to them for their services can be but inadequately expressed.

Conjoint work with other centres previously mentioned in recent Reports has continued to develop. It will be recorded in detail in due course. Further reference here may be confined to the Willow Variety Trial Scheme which was reported last year to be under arrangement. This scheme, in which the Somerset County Council, the willow growers of that county and the Willow Officer of the Institute are jointly concerned, has now been established, and the available land has been planted with the varieties of willows selected for trial.

Berkeley Square Advisory Centre.

Since the Advisory section of the present Report contains comprehensive accounts of the varied activities of this Centre, there is no occasion at this point to refer to them individually. They serve to show continued satisfactory progress of the work and the evident appreciation of the help which the Centre is rendering to agriculture in the Bristol Province.

The organisation of the work of the Centre has remained under the direction of Professor J. A. Hanley, the Chief Advisory Officer for the Bristol Province. His acceptance of the appointment of Principal of the Royal Agricultural College, Cirencester, reported last year, has necessitated his going into residence at the College. In consequence he is in attendance at Berkeley Square for part time only. In his absence general charge of the work there is taken by Mr. A. W. Ling, the Adviser in Agricultural Chemistry.

Among the staff changes to be recorded, particular reference must be made to the heavy loss sustained by the Centre, and the Bristol Province generally, by the acceptance of a post in the Agricultural Department of Cambridge University by Mr. E. P. Weller, the late Adviser in Agricultural Economics. He has been succeeded by Mr. C. V. Dawe, M.Com., who had previously been engaged on similar work in the Agricultural Department of Leeds University.

The other staff changes have been as follows :—

A. de M. Chesterman, P.A.S.I., appointed Student-Assistant in Agricultural Economics.

G. T. Roy, appointed Student-Assistant in Agricultural Economics.

J. D. Nutt, N.D.A., appointed Recorder of Grass Land Experiment in Wiltshire.

Campden Research Station.

With no staff changes or other serious interruption of normal work it has been possible to consolidate still further the position of the Station as the advisory and research centre of the commercial canning industry in this country. The continued uncertainty as to the arrangements for its future have prevented any noteworthy new developments but, in spite of difficulties incidental to the situation, useful progress has been made in all directions and the value of its work has been recognised freely in a variety of ways by the preserving industry and others concerned.

During the year there has been a marked increase in the number of visitors to the Station. It now appears to be getting much better known and many small parties have been shown round during the period. On May 8th a deputation from the Ministry of Agriculture for Northern Ireland was received. On May 23rd the Station was visited by members of the National Food Canning Council who were holding the second Canners' Convention at Worcester; over 100 people went round the Station on that occasion. The Station has also been visited by Sir William Hardy, Mr. Morris and Mr. Barnard of the Food Investigation Board. In addition to the above, many growers and representatives of firms interested in fruit and vegetable preservation have visited the Station.

On the educational side courses of instruction have been held as in previous years and, in addition to this, Miss Adams, the Instructress, has carried out much extension work, mainly in conjunction with the Federation of Women's Institutes, in the form of lectures, demonstrations and judging of produce and educational exhibits at Shows.

PROGRESS REPORT ON FRUIT BREEDING.

By G. T. Spinks.

The work of observing the Long Ashton seedlings of the various fruits has been continued as in previous years, and individuals of promise have been selected for propagation and further trial. All the information which seems likely to be of value has now been obtained from large numbers of plants, and it is possible to discard all the individuals which are themselves of no value. Many plants which have only fruited once or twice are being kept until further observations and descriptions have been made, though most of these plants will doubtless be discarded before long. The small percentage of seedling varieties which appear to be of value are, of course, being propagated in order to give them a trial on a more extensive scale. A few selected varieties of apples, black currants, raspberries and blackberries have now been included in the variety trials which are being carried out at Wisley by the Ministry of Agriculture and the Royal Horticultural Society.

Further seedlings will be raised as the result of crosses which were made in the spring. These include apples, raspberries and strawberries and will consist partly of entirely new families and partly of additions to families in which the existing number of individuals is small.

Further details of the work on the various fruits are given under separate headings below :—

Apples.—This year about 400 individual seedlings bore fruit, and of these about 150 were cropping for the first time. In several families the majority of the individuals have now fruited, and it is possible to see what proportion of the seedlings have inherited certain characters of the parents.

The results previously noted in certain families of open-pollinated seedlings have been confirmed. The seedlings from seed of Lord Derby and Bismarck in many respects resemble very closely their seed-parents, and this has now been found to be the case with seedlings of Jonathan, Wealthy and Frogmore Prolific also. This resemblance to the seed parent is not so marked in seedlings from Allington Pippin and is rare in seedlings from Cox's Orange Pippin.

In a few families of crosses a large proportion of the trees have now fruited and the inheritance of certain characters from the parents can be traced. In the family Allington Pippin x Worcester Pearmain about 30 trees have borne crops and there is a large range of difference among the fruits; but until the descriptions of the fruits have been more carefully analysed it is not possible to draw any conclusions about the inheritance of various characters.

The variety Court Pendu Plat was one of the parents in a number of families which are now fruiting and about 50 seedlings having this variety as one parent have carried a crop. Although several different varieties are represented among the other parents of these 50 seedlings it is noticeable how often certain characters of Court Pendu Plat appear in the seedlings—*e.g.* the late-flowering habit of the tree and the shape, texture and flavour of the fruit.

Although the majority of the above mentioned seedlings are in themselves of little value, yet they have yielded information which will be of value in future attempts to produce certain characters in seedlings by means of crossing. For instance, it appears that many of the characters of Court Pendu Plat are readily transmitted to seedlings having that variety as one of its parents, but the use of Cox's Orange Pippin as a parent will result in the occurrence of the characteristic Cox flavour in only a very small percentage of seedlings.

Several of the seedlings which had been selected for propagation in previous years were again very satisfactory, but one or two of the chosen varieties were rejected this year. A few of the previously selected trees bore poor crops this year, though the quality of the fruit was maintained. Several additions were made to the list of seedlings to be propagated for further trial and this now includes about 10 varieties of dessert apple, varying in season from August to January. Some of these may fill gaps in the season when there are no satisfactory commercial varieties available, and others may possibly prove superior to older varieties of the same season.

Two seedlings have been propagated on account of their probable value for cider-making. The fruit of both is in the sweet class but is in season much later than most of the existing varieties of sweet apples.

A considerable number of pollinations were carried out in the spring. The cross Worcester Pearmain × Mackintosh Red was repeated and Worcester Pearmain was also crossed with the variety Delicious. Both these crosses produced a fair quantity of seed. The cross James Grieve × Mackintosh Red, however, produced no

fruit, this being a similar result to that obtained last year when a large number of pollinations resulted in a very poor set of fruit. Self-pollination was performed on a number of seedling trees whose fruit showed some special point of interest, such as great acidity, abnormal sweetness, specially good flavour or good colour. None of these pollinations resulted in the production of any fruit and they will be repeated, though it is quite possible that the failure to set in the case of the self-pollinations was due to self-sterility of the trees. This is one of the factors which hinders progress in the systematic breeding of apples.

Pears.—About 30 pear seedlings bore fruit this year, this being the first crop on all except three of that number. Eight of these belonged to the family Louise Bonne of Jersey × Conference, the remainder being derived from William's Bon Chretien × Conference. It is notable that the fruit of about ten seedlings was of good or fairly good dessert quality, while only two varieties bore fruit which was classed as definitely poor. The shape of the fruit varied considerably, and in some cases was decidedly unattractive.

The tree which was selected last year bore a heavy crop this year and the fruit was again of excellent quality. The habit of growth of this tree is also very good and the variety is certainly worth propagating. Several other seedlings may be propagated, though the selection of these may be deferred until they have borne another crop.

One point on which little information has yet been obtained is the susceptibility of the seedling varieties to scab. The past season was not favourable to the development of the disease, and the liability of the different seedlings to attacks of scab must be noted in another year.

Plums.—This year crops were obtained from about 50 seedling trees, 25 of which had not fruited before. The fruit ranged from very early to very late in season, and there was also a great range in its character. Some of the plums were suitable for dessert, others for culinary purposes, and they varied widely in regard to size, colour and flavour. It was noticeable that in some families the different seedlings commonly resembled each other and one of their parents in some respects, while in other families the individuals showed no obvious resemblance to each other or to their parents.

Taking only the character of the fruit into consideration, there would appear to be little difficulty in selecting a number of good varieties of different seasons and suitable for different purposes. Several of the best varieties are being propagated, but their true

value will only be apparent when their cropping habits and susceptibility to disease have been noted for several years.

Several seedlings whose parents are known were self-pollinated in an attempt to raise an F_2 generation. All proved to be self-fertile to some extent and a fair number of seeds have been obtained.

Black Currants.—Crop records were again obtained from the small trial plantation of selected black currants. The crops of several varieties were seriously diminished by a severe frost which occurred when the bushes were in flower. Notwithstanding the frost, several varieties cropped well: these included three which were among the best last year and two others which had not previously cropped so well.

The young bushes raised from selected plants in a later batch of seedlings are now being planted out to form a larger trial plantation. Bushes propagated from the best of the older seedlings mentioned above are also being included in the new trial.

Raspberries.—Records have again been taken of the seedling varieties included in the trial plot of standard varieties of raspberries. Two of the seedlings appear to be worth a further trial. One is a good cropper, and though the fruit is rather small it is firm and has a good shape, colour and flavour and may be useful for bottling purposes. The other seedling of promise is notable for the earliness of ripening of its fruit, but the berries are rather small and it is probable that the chief value of this variety will be as a parent in breeding other early-ripening varieties: it has already been used for this purpose. Two other seedlings in the trial plot now appear to be unworthy of further consideration.

A more recently planted part of the trial plot includes four additional seedling varieties of raspberry and these bore their first crop this year. Fruit of these varieties had previously been obtained only from the original seedling plants which were selected from a number of others. One variety bore a good crop of berries which are of good quality in every way. This variety, a seedling from Alexander Autumnal × Red Cross, is distinctly promising and has been propagated for a more extensive trial. The other seedling varieties, two of which have the same parentage as the above, now appear to be much inferior and are probably not worth propagating.

About 250 seedlings which are crosses between (1) Norwich Wonder and Royal and (2) Norwich Wonder and Baumforth A fruited this year for the first time. Descriptions of the plants and the fruit have been made. A number of plants were notable for the crop and the size and quality of the fruit, but none are being

propagated until the result of next year's cropping is seen. One of the objects aimed at in making these crosses was earliness of ripening of the fruit, but no seedlings of extraordinary earliness have been noted.

The family of 150 seedlings from Norwich Wonder x Baumforth A contains 22 plants of the *obtusifolius* type which have been noted by other breeders of raspberries. These plants have very distinctive leaves and the flowers bear functional male organs only and thus form no fruits.

New crosses were made this year between Lloyd George, Improved Beehive and an early ripening seedling. Each variety was crossed with the other two, the object being to combine size, heavy crop and earliness. A satisfactory quantity of seed was obtained.

Blackberries and other Rubi.—The selected seedling blackberries gave a small crop this year owing to the necessity of moving the young plants last winter, but there seems every prospect of fulfil ment of the early promise of the seedlings for vigour, heavy crop, and earliness of fruit.

A number of canes which are the product of various combinations of blackberries with raspberries or loganberries bore very little fruit. Some have not yet made sufficient growth and bore no flowers, but others bore apparently perfect flowers and yet set no fruit or only small imperfect fruits with a few drupelets. It seems probable that most of these plants will be useless owing to this sterile condition often found in hybrids.

Strawberries.—The families of seedlings named in the last Report have made very good growth during the year. The maiden seedlings were not allowed to fruit and in consequence the majority have made large strong plants with a number of crowns and should carry a good crop next year. In the autumn a preliminary inspection of the plants was made and the numbers affected by aphis or mildew were noted. Up to the present it appears that the varieties resistant to aphis attack have conferred a large measure of resistance on their offspring, for only a small percentage of plants show the characteristic symptoms of damage, although aphis is present in abundance on most of the plants. Stirling Castle seems to produce more susceptible plants among its progeny than does Royal Sovereign, the other parent in each case being a resistant variety. It should be noted that these conclusions may be modified after inspection of the plants next year when the aphis has had more time to affect them.

In some families a large number of plants had been badly attacked

by mildew and apparently susceptibility to the attack of this disease was conferred more by Royal Sovereign than by any other parent.

In two families, Dumbarton Castle selfed, and Sturton Cross selfed, almost all the plants are very small and weak, but it is at present uncertain whether this is due to the weakness often inherent in selfed seedlings or to some other cause.

Next summer the resistance of the plants to aphis attack and the quantity and quality of the fruit will be noted. Any plants in which the desired characters are combined will be propagated for further trial.

FACTORS GOVERNING FRUIT-BUD FORMATION—IX.

SOME OBSERVATIONS UPON THE LEAF AREA OF SPURS ON BIENNIALLY BEARING APPLE TREES.

By Thomas Swarbrick.

Introduction.*

The widespread occurrence of the biennial bearing of fruit trees is such as to constitute a problem of considerable economic importance. The benefits which accrue from regular cropping are too obvious to need any elaboration at this point, so that any efforts which may be put forward to overcome the difficulty have a direct practical value. The problem has already received some attention from American workers, but the widely different climatic and soil conditions render an investigation of the problem in this country of considerable importance to English horticulturalists.

From the present point of view, the primary physiological problems involved in biennial bearing are the conditions governing fruit bud formation, and the conditions that lead to the formation of flower buds in alternate years. From such knowledge it should be possible to work out a practical method of obtaining regular annual crops of blossom. It is, of course, by no means certain that a crop of fruit will always follow a good crop of blossoms, but nevertheless, a good show of blossom is the first essential for a good crop of fruit. In practice a succession of total crop failures which can be attributed to adverse weather at blossoming time is of rather rare occurrence so that, for practical purposes at least, blossom formation is most likely to be the largest single factor limiting fruitfulness. This is particularly true where care has been exercised in the selection of an orchard site. Orchards planted in locations which do not allow of adequate air drainage are predestined to suffer severely from late spring frosts whenever these occur.

* Mr. C. E. T. Mann, formerly Research Plant Physiologist at the Station, collaborated with the author in the collection of the data recorded in this paper. On his appointment to a post in The Federated Malay States the records were left with the present writer who has worked them up into their present form.

The immediate problem, therefore, is to obtain a knowledge of the physiological conditions which favour flower bud formation regularly year after year on trees that, at the same time, are carrying annual economic crops of fruit. A study of trees in the biennially bearing condition offers an attractive avenue for an attack upon the above problem.

The present paper is preliminary to further work. The work reported upon herein has served to indicate several suggestive lines of investigation for the future. These are being taken up as opportunity affords, and it is fully expected that they will result in information of practical value. The basic idea underlying this future work is to discover the kind of tree and type of spur growth that are associated with the fruiting conditions we desire to obtain. Having once definitely established a relationship between certain growth characters in a tree and its potential fruiting capacity—*e.g.* the formation of fruit buds—it should not be a very difficult matter to evolve practices that will give us the kind of growth that we want. In the nature of the case, if it be true that certain anatomical and morphological responses are associated with or follow certain definite kinds of tree growth, then under different climatic and soil conditions it will be necessary to evolve *different* cultural methods in order to obtain the *same* physiological condition in the trees. It would also follow that no one cultural or other orchard practice can have universal application, and that the employment of all cultural and orchard practices must be based upon the growth responses they engender under the particular climatic and soil conditions. It is reasonable to expect, therefore, that cultural practices eminently suited to the drier eastern side of England will be quite unsuited to the west of England with its relatively moist climatic conditions. A discussion of the physiology of these and similar problems is reserved for a future occasion.

In the present paper certain points of importance and interest arising out of an investigation of the leaf area of biennially bearing trees are presented. For several years it had been noted in a general way by Professor Barker and his associates at Long Ashton, that trees in a biennially bearing condition alternate from year to year not only in amount of crop but also in amount of leaf area. It had been noticed that when there was a heavy crop of fruit there was a paucity of leaf area, particularly early in the season. In the "off" years, however, there was a much larger leaf area carried by these trees. It is clear, therefore, that in these trees, the year of flower bud initiation was the "off" year for fruit but the "on" year for leaf area. In biennially bearing trees at least, blossom bud initiation is apparently associated with the larger leaf area of

the "off" year, and a failure to initiate blossom buds accompanies the paucity of leaf area of the spurs during the "on" year. The above general observations relating to the alternation of leaf area in biennially bearing trees naturally strengthens the idea that flower bud formation is closely associated with an adequate leaf area in close proximity to the potential flower bud.

In Spring 1925 several large biennially bearing apple trees were available at Long Ashton. These afforded suitable material for placing the above general observations upon a more quantitative basis and, at the suggestion of Professor Barker, the leaf area measurements herein reported were initiated.

In view of the observations mentioned above, the question naturally arose as to the relation of leaf area to blossom bud formation. There was also the question of the cause of the observed lower leaf area of the "on" year. If this be a direct result of carrying either blossoms or fruit then their removal ought to be followed by an increased leaf area which in its turn ought to be followed by blossom bud formation in the year of deblossoming.

Observations made over a number of years lead to the idea that biennial bearing is associated with a definite kind of growth. To eliminate biennial bearing therefore it will be necessary to bring about a different growth distribution in the tree as a whole. While work is being initiated along these lines, the observations already made upon the leaf area of biennially bearing trees are reported at this stage.

Method of Procedure and Material Employed.

Two standard apple trees of the variety Court Royal growing in the Research Station cider apple orchard were selected for observation. These trees are growing upon seedling rootstocks. They were planted in the winter 1903-04 in a grass orchard. For two years the ground in the immediate vicinity of the trees was kept cultivated so that no grass was allowed to grow. After this the orchard was managed as a typical grass orchard until the early years of the war. It was then ploughed up and the trees were interplanted with black currants, and the ground kept cultivated. This system continued until 1926, when the black currant bushes were removed and the orchard again allowed to grass over. The trees are of good size and are quite healthy. The measurements were made on two trees selected from amongst others, all of which are known to have produced crops in alternate years only, over a period of several years. Furthermore, one of these trees was in crop when the other was without a crop. Thus,

not only were the selected trees biennial bearers of long standing but they alternated with each other in their "on" and "off" years.*

For convenience of reference the tree which cropped in 1925 has been designated "A" and that which cropped in 1926 "B." Thus, A was "on" in 1925 and "off" in 1926, whereas B was "off" in 1925 and "on" in 1926.

As it was intended to obtain if possible a typical and representative series of observations, several medium sized subsidiary branches were selected on each tree. These branches were then suitably labelled. As far as possible comparable branches were chosen. These were for the most part on the south-east side of the trees and were about $2\frac{1}{2}$ inches in diameter at the junction with the main scaffold branch.

Starting at the base of the branches, all the leaves of the spurs and lateral outgrowths were measured and recorded. Measurements were in every case of the greatest length and greatest width of the leaf lamina. The location of each spur or outgrowth was so described in the field book that it could be readily identified in the following year. Measurements were made on both trees on June 3rd to 5th, 1925, and again in 1926 on June 15th to 18th. In this way a two-year record of the leaf area of known spurs of both trees was obtained.

When the measurements were being made, typical spurs and laterals were collected and the actual leaf area of the individual leaves was determined by pressing and then outlining them on to squared paper. The calculated area of the leaf obtained by the simple multiplication of length by breadth when divided by the actual area of the leaf obtained as above gave a "factor" which could be used to obtain the *actual* from the calculated area of any set of leaves. Despite the somewhat consistent difference in leaf shape that existed between the youngest and oldest leaf of a spur or lateral, the "factor" obtained for any single leaf of a spur or lateral showed comparatively little variation from the mean of all the leaves. This "factor" along with the actual and calculated leaf area of a typical set of spur leaves is shown in Table I. The use of such a "factor," while it enables us to obtain the actual leaf area of a spur, does not alter the proportions the leaf areas bear to each other. For economy of space and convenience of reference, therefore, the calculated areas only are given in Tables II, III, IV and V. The *actual* areas are given in Table VI.

* Owing to the extension of the laboratories at the Research Station in 1928 one of these trees had to be removed. It was unfortunate that this particular tree was lost because it was the only one which was in crop when the rest of the Court Royal trees in the orchard were without a crop.

TABLE I.

Showing the actual and the calculated leaf area of the leaves of a spur of Court Royal Apple; and the range of variation in the leaf factor. Leaves in order of development.

No. of Leaf.	Length of Leaf. cms.	Greatest width of Leaf. cms.	Calculated area (length x width) sq. cms.	Actual Area. sq. cms.	Factor $\frac{\text{actual}}{\text{calculated}}$
1	1.1	1.0	1.1	0.88	.80
2	1.4	1.4	1.96	1.28	.69
3	1.8	1.4	2.52	1.68	.66
4	2.3	2.1	4.83	3.13	.65
5	2.5	1.8	4.50	3.04	.67
6	3.0	2.0	6.00	4.38	.73
				average for factor—	.68

Table I gives the data for the individual leaves of a single typical Court Royal spur. It will be observed that this spur had six leaves which in Table I are given in order of development, that is from the base of the spur upwards. On the average the spurs measured do not have six leaves each, but the spur taken for detailed examination in Table I shows a wider range of leaf shape than would an average four or five leaved spur. Reference to Table I will show that there is a very definite difference in leaf shape between the oldest and youngest leaves of a spur. Thus leaf number one has a width almost equal to its length, whereas the length of the youngest leaf is much greater than its width. In the younger leaves, therefore, there is a greater discrepancy between the actual and the calculated leaf area than there is in the older leaves. The ratio between the actual and the calculated area of the leaves does not show a very wide variation notwithstanding the difference in leaf shape. For the spur leaves given in Table I the average for the "factor" is 0.68. Four of the six leaves do not vary from this average more than 0.03 and two of them by only 0.01. The youngest leaf varies from the average by 0.05 and the oldest by 0.12. In this latter case even this wide variation is not a serious matter, because the leaf area involved is so small, being only about 6% of the total spur leaf area involved. For the present purpose, in order to obtain the actual leaf area of a spur when only its calculated area

is known, it is regarded as sufficiently accurate to employ an average "factor" obtained as above. The error introduced by using this factor is not more than 25%, whereas the differences in leaf area involved are between 300 and 400%. It is clear, therefore, that the method of analysis employed is adequate for the present purpose.

It is clear from the above discussion that for purposes of comparison the calculated leaf is a convenient index. For those who desire the data in actual amounts they are given in Summary form in Table VI.

In this study data were also collected in a similar way to that described above for the Court Royal trees from a large number of spurs of biennially bearing bush trees of the apple variety Bramley's Seedling. These data are not given here, but they substantiate in every way the general conclusions herein put forward. It was clear, however, that the "factor" for Bramley's Seedling leaves differed considerably from that of the Court Royals. If, therefore, a comparison of the leaf areas of different varieties is contemplated it appears advisable to compare only the actual and not the calculated leaf areas.

The Alternation of Spur Leaf Area during the Biennial Cycle.

Tables II and III give in a condensed form the various observations which were recorded from trees A and B respectively over the period 1925-26. As previously stated the measurements were made during June in each of the above years. The amount of data presented in these tables has been quite arbitrarily limited to forty spurs per tree, these being the first forty spurs as they were entered in the field book, except that spurs which were vegetative during both seasons are passed over. The data relating to these latter spurs are collected together into Tables IV and V and discussed in a separate section. Between eighty and one hundred spurs, as well as short laterals and terminal growths, were subjected to examination and measurement on each of the above trees, so that there are additional data available beyond those presented herein. Economy of space does not permit of the presentation of the data in full. Those presented in Tables I to VI inclusive, however, are in every way typical of the whole.

TABLE II.

Showing the records taken on Tree A (variety Court Royal) during June in the seasons 1925-26. This tree bore a crop in 1925 but no crop in 1926.

Measurements in cms. and sq. cms. Area given as calculated from a simple multiplication of length by breadth.

Spur No.	Number of Leaves per Spur.		Number of Leaves per Bourse Bud. 1925.		Leaf Area per Spur. 1925.	Total Leaf area including Bourse Bud Leaves.		Leaf Area on Bourse Buds		No. of Flowers per Spur.
	1925.	1926.	Bud 1	Bud 2		1925.	1926.	Bud 1	Bud 2	
1	4	6	—	—	13.8	13.8	76.6	—	—	6
2	5	8	5	—	33.9	89.7	199.1	55.8	—	6
3	4	9	3	—	27.2	64.4	191.4	17.2	—	6
4	3	6	4	—	12.4	77.0	111.3	64.6	—	6
5	4	7	4	—	28.2	120.2	214.5	92.0	—	6
6	3	7	2	—	22.5	61.1	149.3	38.6	—	6
7	4	8	4	—	27.1	79.5	136.0	52.4	—	5
8	4	3	—	—	23.6	23.6	13.6	—	—	5
9	5	8	3	—	33.7	88.5	162.7	54.8	—	6
10	5	7	—	—	29.2	29.2	113.6	—	—	5
11	4	10	4	—	32.8	86.2	331.8	53.4	—	6
12	4	5	1	—	28.2	47.0	64.8	18.8	—	6
13	4	8	1	—	23.4	36.2	97.2	12.8	—	7
14	7	8	—	—	53.8	53.8	146.2	—	—	6
15	4	7	1	—	22.0	44.0	152.3	22.0	—	6
16	4	7	2	—	22.9	50.3	154.9	27.4	—	7
17	4	6	—	—	46.8	46.8	71.1	—	—	6
18	5	6	—	—	34.5	34.5	55.3	—	—	6
19	5	9	2	—	45.5	55.8	129.6	10.3	—	5
20	5	5	—	—	22.5	22.5	59.3	—	—	6
21	4	5	2	—	20.3	48.7	50.4	28.4	—	7
22	4	4	—	—	23.0	23.0	23.0	—	—	6
23	6	4	—	—	34.1	34.1	20.5	—	—	5
24	5	8	2	—	57.1	95.5	155.5	38.4	—	5
25	3	5	4	—	20.5	73.9	72.2	53.4	—	6
26	4	8	3	—	21.3	78.5	151.8	57.2	—	6
27	4	8	1	—	29.3	38.8	192.3	9.5	—	6
28	4	7	1	—	22.1	26.9	136.8	4.8	—	6
29	3	9	—	—	23.0	23.0	155.2	—	—	6
30	4	7	—	—	29.6	29.6	148.3	—	—	7
31	5	6	—	—	47.0	47.0	143.0	—	—	2
32	6	9	—	—	64.6	64.6	215.0	—	—	7
33	4	6	—	—	36.5	36.5	60.9	—	—	6
34	9	9	—	—	65.0	65.0	220.3	—	—	6
35	5	8	2	—	23.2	45.8	170.4	22.8	—	6
36	5	4	—	—	38.7	38.7	71.7	—	—	6
37	5	10	4	—	45.9	110.9	300.3	65.0	—	6
38	5	3	1	—	14.8	26.8	21.2	12.0	—	5
39	4	8	—	—	27.9	27.9	167.4	—	—	6
40	5	8	—	—	49.0	49.0	184.8	—	—	6
Totals	181	275	56	—	1288	2100	5193	812	—	

TABLE III.

Showing the records taken on Tree B (variety Court Royal) in June, during the seasons 1925-26. This tree bore a crop in 1926, but no crop in 1925.

Measurements in cms. and sq. cms. and given as calculated from the simply multiplication of length by breadth of leaves.

Spur No.	Number of Leaves per Spur.		Number of Leaves per Bourse Bud. 1926.		Leaf Area per Spur. 1926.	Total Leaf area including Bourse Bud Leaves.		Leaf Area on Bourse Buds		No. of Flowers per Spur.
	1925.	1926.	Bud 1	Bud 2		1925.	1926.	Bud 1	Bud 2	
1	9	5	1	1	37.7	253.3	84.2	23.5	23.0	5
2	7	5	1	1	18.0	149.8	22.1	2.6	1.5	6
3	6	5	—	—	26.5	137.8	26.5	—	—	5
4	7	6	—	—	52.9	150.1	52.9	—	—	6
5	6	3	2	—	13.7	98.1	45.2	31.5	—	5
6	9	6	3	—	39.1	253.7	104.8	65.7	—	7
7	8	4	2	—	22.0	206.2	40.1	18.1	—	6
8	9	4	2	2	21.4	196.5	91.3	44.0	25.9	6
9	5	6	2	—	43.8	114.6	98.4	54.6	—	5
10	8	3	4	—	34.0	224.4	114.0	80.0	—	6
11	8	3	2	—	19.3	224.2	57.7	38.4	—	6
12	8	5	2	4	30.7	115.5	179.1	45.2	103.2	7
13	6	5	1	—	26.3	125.7	50.7	24.7	—	6
14	7	3	1	—	18.5	145.7	43.1	24.6	—	4
15	7	5	5	—	19.2	100.8	102.0	82.8	—	6
16	6	3	2	—	19.6	102.7	65.3	45.7	—	6
17	9	3	3	3	44.4	481.4	224.9	83.5	97.0	7
18	8	3	2	2	13.8	180.7	74.0	26.2	34.1	6
19	8	6	1	2	41.2	173.1	78.4	9.2	28.0	6
20	8	5	—	—	20.9	169.7	20.9	—	—	5
21	6	4	1	—	21.0	130.4	37.2	16.2	—	4
22	4	4	—	—	10.1	64.6	10.1	—	—	6
23	7	6	—	—	34.7	119.0	34.7	—	—	7
24	9	5	2	2	29.5	268.6	105.5	25.5	50.5	5
25	8	4	2	2	26.6	202.9	86.6	33.2	16.8	5
26	5	4	—	—	28.9	101.4	28.9	—	—	6
27	7	4	—	—	13.5	154.7	13.5	—	—	6
28	8	6	—	—	32.4	143.3	32.4	—	—	6
29	8	4	—	—	30.8	171.1	30.8	—	—	7
30	8	5	2	—	27.7	204.4	59.6	31.9	—	7
31	9	4	2	—	25.0	273.2	78.3	53.3	—	6
32	6	6	2	—	50.3	109.5	94.8	44.5	—	6
33	11	6	4	3	60.2	312.0	280.4	149.1	71.1	6
34	5	5	2	—	77.0	104.5	130.2	53.2	—	6
35	11	6	6	3	46.4	205.4	235.5	121.8	67.3	6
36	8	5	2	—	22.4	171.0	70.6	58.2	—	7
37	8	4	2	—	33.5	183.3	90.5	57.0	—	6
38	6	7	—	—	86.5	39.1	86.5	—	—	6
39	4	3	3	—	40.4	54.3	58.3	17.9	—	6
40	3	3	—	—	76.6	294.7	142.4	66.8	—	5
Totals	270	181	66	25	1366	6911	3282	1916		

In Tables II and III are given separately the data of forty numbered spurs on each of two trees. The data given include the number of spur leaves developed each year. In the case of trees in their "on" year these do *not* include the leaves developed from bourse buds.* These are given in a separate column. In a similar manner, the leaf *area* of the spur leaves does not include that of the bourse bud leaves but only those leaves originally present on the cluster base, *i.e.* those leaves which were present within the flower bud along with the flowers. The total leaf area of the spur *including* the bourse bud leaves is given, also that of the bourse bud leaves. The number of flowers per spur is also given. These data appear to include all that is necessary for the present purposes.

It will be noticed that except in a few cases in Tables II and III the number of leaves per spur does not fluctuate widely from the average. It will be noted, however, that the number of leaves per spur is greater in the "off" years than the "on" years. The observations relating to the difference in leaf shape between the older and younger leaves given in the discussion of Table I apply throughout the data of Tables II and III.

From Tables II and III it is possible to draw the following tentative generalisations :—

Considering first the two trees in their "on" or "off" years respectively and without regard to the fact that in 1925 one of the trees was in its "on" and the other in its "off" year, it is seen that, in their "on" or "off" years, the average *number* of leaves per spur is remarkably similar. Thus, in the "on" year for each tree they both had 181 leaves distributed over the forty spurs, or an average of 4.5 leaves per spur. In the "off" years tree A had 275 and tree B 270 leaves on the same forty spurs. There is, therefore, a difference of only five leaves between these 80 spurs in the two-year cycle.

While there is this marked similarity in the number of leaves per spur when the trees are compared upon a basis of crop—*i.e.* when the "on" or "off" years are compared—yet there is a wide difference in the number of leaves per spur from year to year. In

* The apple flower bud in contrast with the plum and peach flower buds, is almost invariably a mixed bud, *i.e.*, contained within the bud scales there are (a) flowers in a more or less developed state ; (b) subtending the flower cluster a number of leaves. Axillary buds are of course developed in the axils of these leaves. In Horticultural practice these buds are known as *bourse buds*, and the region from which they arise as the *cluster base*. In spring when the flower bud opens the flower cluster is subtended by a condensed spiral of leaves. About the period of blossom fall one or more of these bourse buds may develop into shoots. *These are bourse bud shoots.* Depending upon conditions of development these bourse buds shoots may grow into long extension shoots or into short fruiting spurs.

the " off " years the number of leaves per spur was half as much again as it was in the " on " years. Although these trees were alternating with each other in respect to the year of crop, the average number of leaves per spur for the " on " years was 4.5 and 6.9 for the " off " years. Thus, there was a 50% fluctuation in the number of leaves per spur from year to year in these biennially bearing trees.

Although there is a difference of about 2.5 leaves per spur between the same spurs in their " on " and " off " years, this difference in number of leaves gives no adequate indication of the large fluctuation in leaf surface that is involved. In the case of tree A, the average *actual* leaf area per spur (represented by 4.5 leaves) in the " on " year was 22.0 sq. cms., whereas on the same spur in the following year—which was the " off " year—it was 91.0 sq. cms. (represented by 6.9 leaves). It is pointed out that while the number of spur leaves was only increased by 50% the leaf area involved was increased by approximately 300%. This difference is obviously almost entirely due to larger and more vigorous leaves produced in the spring of the " off " year. The difference between the leaf area of spurs in their " on " and " off " years is still more strikingly shown in the case of tree B, where the leaf area per spur in the " off " year (represented by 6.9 leaves) was 120.0 sq. cms., whereas in the following " on " year it was only 23.0 sq. cms. (represented by 4.5 leaves). As compared with the " on " year, the leaf area per spur in the " off " year was increased by approximately 400% notwithstanding the fact that the number of leaves was only increased by 50%.

From the data given above it is clear that the fluctuation in leaf area from year to year in biennially bearing trees previously observed in a general way at Long Ashton, is due, not so much to a larger number of leaves per spur in the " off " year as to a much larger area per leaf. The nett result from an observer's point of view is the same. The tree appears to have a much more foliage in the " off " year than it has in its " on " year.

The foregoing generalisations are based upon an analysis of the data for spur leaves only, and do not include an examination of the leaves borne upon developing bourse buds. It is perhaps unnecessary to point out that there are no bourse buds developing during the " off " year. In that year the whole of the leaf area is carried upon spurs, and lateral or terminal shoots. It is shown by Tables II, III and VI that, of the *total* leaf area of the trees in the " on " years, at least half of it is to be found upon developing bourse buds. The number of bourse buds which develop varies between these two trees, 22 from the 40 spurs of A as against 40 from the

same number of spurs on B. This difference is no doubt due to the slightly greater vigour of tree B.

It is interesting to note that the average size of the bourse bud leaves is about twice that of the average spur leaves of the " on " year. It is clear from Table VI that the much larger leaf area of tree B than of tree A in their respective " on " years was due almost entirely to leaves of bourse buds. The importance of bourse bud leaves in the " on " year of biennially bearing trees is evident

In general, the trees in their " on " years carried only about half the *total* leaf area that they carried in the " off " years and, of the total leaf area carried during the " on " year at least half of it was to be found upon developing bourse buds. In the " on " years the spur leaf area—*i.e.* of leaves originally present in the bud along with the flowers—was only about one quarter the amount the same spurs carried in the " off " years.

The Leaf Area of Spurs which were Vegetative throughout this Study.

Tables IV and V give the areas of spurs which remained vegetative during both years.* Those of tree B are particularly interesting as by a study of them it is possible in some measure to see how far leaf area is concerned directly with flower bud formation in these trees. These tables permit of the following generalisations :—

In the " on " year for both trees the average leaf area of the vegetative spurs was greater than the average leaf area for spurs carrying flowers but less than that of the spurs during the " off " year. This would seem to indicate that in some way the carrying of flowers by the majority of the spurs of the tree has had an adverse effect upon the leaf area of the vegetative spurs during the early growing season.

* The term vegetative spur is here employed in its general usage, *i.e.*, to mean a spur which has not blossomed in the spring of the year under consideration. Thus in biennially bearing trees the spurs are vegetative spurs in the " off " year and flowering spurs in the " on " year. Spurs which do not flower at all may be called permanently vegetative spurs.

TABLE IV.

Showing the leaf area and number of spurs on Tree A which were vegetative spurs in 1925 and 1926. This tree bore a crop of fruit in 1925. 1926 was an "off" year.

Areas in sq. cms., given as calculated from length by breadth of leaves.

Tree A. 'ON' in 1925.	Number of Leaves per spur.		Total Leaf Area per spur.	
	1925.	1926.	1925.	1926.
1	6	6	90.6	100.5
2	6	6	82.4	122.7
3	6	7	77.9	163.1
4	6	7	68.8	128.0
5	6	8	70.2	133.8
6	6	8	77.1	289.9
7	4	7	84.7	70.5
8	7	9	122.0	160.7
9	4	8	122.4	105.7
10	6	10	43.1	314.9
11	7	7	125.8	100.7
12	5	5	83.0	52.8
13	6	11	19.1	38.4
14	5	8	28.2	140.7
15	5	7	31.2	167.2
16	5	8	21.6	127.7
Totals	90	122	1158	2223
Average per spur	5.0	7.5	72	139
Average for the forty bearing Spurs as per Table II.	4.5	6.9	32	130

TABLE V.

Showing the leaf area and number of spurs on Tree B which were vegetative spurs in 1925 and 1926. This tree bore a crop of fruit in 1926. 1925 was an "off" year.

Areas in sq. cms., given as calculated from length by breadth of leaves.

Tree B.	Number of Leaves per spur.		Total Leaf Area per spur.	
'ON' in 1926.	1925.	1926.	1925.	1926.
1	5	6	54.0	78.0
2	3	1	14.3	9.6
3	3	3	9.1	20.1
4	4	5	37.3	66.1
5	4	2	74.0	10.4
6	3	5	28.4	36.9
7	5	7	147.1	65.7
Totals	27	29	364.2	286.8
Average per spur	3.9	4.0	52	41
Average for the forty bearing spurs of Tree B as per Table III.	6.9	4.5	171	34

Still continuing the discussion of the vegetative spurs of tree A during its " on " year of 1925, it is clear from Table IV that while these spurs in 1925 carried about twice the leaf area of the flowering spurs of the same tree, yet they did not initiate blossom buds for 1926. In this case, at least the vegetative spurs of the " on " year did not form flower buds, although they had a larger leaf area than the rest of the spurs on the tree. Reference again to Table VI, however, shows that those spurs had an average leaf area of only 50.0 sq. cms. in the " on " year, whereas spurs which are known to have initiated flower buds are shown to have an average leaf area of not less than 91.0 sq. cms. in the " off " year. It is, of course, not possible from the data at hand to determine exactly how much leaf area is necessary under present conditions for flower bud formation. It is possible that 91.0 sq. cms. is well above the amount required, and it is equally possible that 50.0 sq. cms. is well below that mark. In view of the fact that the spurs vegetative in both years on tree B had a very low leaf area in both years, (see Table VI) it is probable that the failure of vegetative spurs during the " on " years to initiate flower buds, is due in a large measure to their very low leaf area. It is probable that in these trees they had not enough leaf area to enable them to initiate flower buds.

Turning now to the spurs of tree B, which were vegetative in both years, it is seen that they have practically the same leaf area in both years. Further, their leaf area is very low, lower in fact than the average for similar spurs on tree A, which on the whole was a slightly less vigorous tree. It would appear, therefore, that on this tree it was the weakest spurs which were the vegetative ones. The leaf area of these spurs in the " off " year was only about one-third of that of neighbouring spurs which initiated blossom buds.

The percentage of spurs which were vegetative in both years of the biennial cycle is interesting, being 21% and 10% respectively for the two trees A and B. The lower percentage for tree B is undoubtedly due to its greater vigour. In this tree these vegetative spurs were in general the weak ones with a very low leaf area, but there was one exception. One of these spurs had a leaf area of 174 sq. cms. in the " off " year, yet it did not initiate a flower bud. Furthermore, three of the vegetative spurs of both years in tree B had a larger leaf area in the " off " year than one of the forty spurs which did initiate a flower bud in its " off " year. These minor exceptions might be regarded as suggesting that leaf area alone is not the only factor which may limit the formation of flower buds in a spur. However, in view of the fact that only one spur out of forty initiated a flower bud with a leaf area *lower* than that carried by spurs which did not initiate blossom buds, suggests strongly that

the leaf area of the spur does exercise a profound influence upon this differentiation.

TABLE VI.

Showing the summary of the observations recorded in detail in Tables I.-V. Leaf areas in *actual* amounts. June 1925 and 1926.

Data from spurs which bore in 1925 *or* 1926.	Tree A. Bearing in 1925.		Tree B. Bearing in 1926.	
	1925.	1926.	1925.	1926.
Average number of leaves per spur	4.5	6.9	6.9	4.5
Average leaf area per spur in sq cms. ..	22.0	91.0	120.0	23.0
Average area per spur leaf „ ..	5.0	13.0	18.0	5.25
„ „ „ bourse bud „ ..	26.0	—	—	33.5
„ „ „ „ leaf „ ..	10.0	—	—	15.0
„ number of leaves per bourse bud ..	1.4	—	—	2.3
Total leaf area per 40 spurs including leaf area carried on bourse buds	1470	3635	4837	2297
Total leaf area on spurs only	901	3635	4837	956
Total number of bourse buds per 40 spurs ..	22	—	—	40
„ leaf area on 40 bourse buds	568	—	—	1341
Data obtained from spurs which did not bear in either 1925 *or* 1926.				
Average number of leaves per spur	5	7.5	3.9	4.0
„ leaf area per spur, in sq. cms. ..	50	97.3	36.0	29.0
Total leaf area of spurs (16 spurs) in sq. cms. ..	810	1556		
„ „ „ „ „ (7 spurs) „ ..			254	172

Thus, the failure of the vegetative spurs of tree A to initiate flower buds during the " on " year appears directly due to an inadequate leaf area per spur. Similarly the spurs of tree B which were vegetative in the " on " year were seen, with one exception, to be spurs which had a very low leaf area during the previous " off " year. In both these cases, therefore, the failure to initiate blossom buds appears directly correlated with an inadequate leaf area.

These conclusions are in themselves interesting, but their value

lies also in the suggestive lines of work which they open up. In any case, it is clear that trees in a biennially bearing condition afford conditions specially suitable for a study of the factors governing fruit bud formation.

A lack of leaf area has been shown to be associated with the failure of spurs to initiate flower buds in these trees. As the amount of leaf area that opens with a spur in spring is in a large measure determined by the conditions under which the bud is laid down in the previous growing season, the present work offers a basis for an experimental attack upon the correction of this habit. Several possible lines of attack are opened up, but their development is not within the scope of the present paper.

Summary and Conclusions.

The leaf areas of two biennial bearing apple trees have been measured and recorded over the two year cycle and a definite relationship between leaf area and blossom bud formation appears to be established.

It is shown that for the present investigation calculated leaf areas of sets of leaves may be converted into actual amounts by the use of an average "factor."

The numerical data are collected together into Table VI and are there given in *actual* amounts.

It is shown that the average *number* of leaves per spur is the same for two trees designated A and B when they are in their "on" year and again when they are in their "off" year. This relationship is not disturbed by the fact that the "on" year of tree A was in 1925 which was the "off" year for tree B.

The *number* of spur leaves carried per spur is 50% greater in the "off" year than in the "on" year. The *areas* of these leaves, however, are 300% and 400% greater respectively for trees A and B in their "off" years than in their "on" years.

The larger leaf area of these trees in the "off" year is due in part to a greater number of leaves per spur but in far larger measure to increased leaf size.

Over half the total leaf area of the "on" year is developed on bourse bud growths. The bourse bud leaves are on the average about twice as large as the spur leaves of the cluster base. The spur leaf areas were almost equal for the trees in the "on" years, but tree B had by far the larger total leaf area in the "on" year because it developed a much larger number of bourse buds.

The total leaf area—including that of the bourse buds—is only half as much in the " on " year as it is in the following " off " year. The spur leaf area of the " on " year is only about one quarter of that of the same spurs in the " off " year.

The leaf area of vegetative spurs during the " on " year is larger than that of flowering spurs on the same tree but is not so large as that of spurs during the " off " year. Thus flowering of spurs appears to be accompanied by a lower leaf area. The leaf area of the vegetative spurs of the " on " year is not greater than one half that of the average for spurs in the " off " year. The fact that these vegetative spurs of the " on " year do not initiate flower buds for the following year is probably due to the small leaf area that they develop. The leaf area of these spurs is never more than half that of spurs which are known to have initiated flowers.

On the more vigorous tree B the spurs which were vegetative throughout the biennial cycle were, with one exception, the very weak ones with a small leaf area.

A study of biennially bearing trees will no doubt afford considerable information of the factors governing fruit bud formation.

THE ABSCISSION OF BLACK CURRANT SHOOTS DURING THE GROWING SEASON.

By Thomas Swarbrick.

In July of this year the Research Mycologist brought to my notice a marked abscission of black currant shoots that was taking place in the fruit plantations. This abscission of the current season's shoots was first observed in a bed of cuttings which had been two years established and had been very hard pruned in spring 1928. As a consequence of the hard pruning there was a large number of young shoots arising from the one year old stumps. Because of this, there was considerable crowding in the beds and growth conditions were obviously not such as would permit of maximum development. Nevertheless this crowding of the shoots could not in itself be regarded as the cause of the abscission because the bushes on the outsides of the beds showed as much if not more shoot abscission than those in the middle. An examination of both well established plantations of black currants and of others established in spring 1928 showed that there was in these beds a considerable amount of abscission, although not so much as in the cutting beds previously mentioned.

It appears that during July and August fruit growers are quite accustomed to having more or less of the " blowing out " of black currant shoots as they call it. As it usually follows or accompanies high winds they regard it as being due to the wind breaking away the young shoots. The writer has not been able to examine commercial plantations where " blowing out " has been taking place, but it is suspected that much of what has been observed is not due to the wind directly but that the shoots have been undergoing a process of abscission for some time previously. If the " blowing out " were due primarily to wind then the young branches would be torn off the parent branch and each would bring away a small splinter of the wood of the parent branch. There would be as a consequence a distinctly rough torn fracture. If, on the other hand, the " blowing out " was preceded by internal changes which produced an abscission layer at the base of the shoot, then when the shoot came away it would not leave a rough fracture but would come away easily, clean and whole. The abscissed shoot would make a perfect ball and socket joint with the parent branch. A

photograph of such a shoot is shown in Figure I. It is quite clear that the " blowing out " here described is not due primarily to high wind since the shoots are obviously cut off by a growth process initiated within the plant. In quite a number of cases shoots were observed to fall over while we were making the observations, even though there was practically no wind at the time.

A marked feature of this phenomenon was the fact that the shoot continued growing and the leaves remained turgid right up to the time of abscission. In most cases, however, the lower leaves of the shoots had brown withered margins. The leaves on shoots not being abscissed did not show this marginal withering. This turgidity of the leaves and continued growth of the shoots is quite surprising since it is clear that there is only a small amount of xylem which could convey the necessary water to the stem and leaves. Microscopic examination showed that while there was a lack of xylem continuity in the region of the abscission layer, yet there was an abundance of parenchyma in this region.

In bush fruits such as the black currant, where the succession of crops is so much dependent upon the production of new shoots, it would be a serious matter if there should occur much of this shoot abscission. Fortunately it does not appear to occur on a large scale except in some years. A similar shoot abscission sometimes occurs among pines and coniferous trees generally, and is quite common in some species of poplars. In these latter plants the young shoots are abscissed in the same condition as that just described for black currant, namely in full leaf, and with the leaves turgid with water. It was also pointed out to the writer that there are certain varieties of gooseberry which persistently absciss such a large proportion of their current year's shoots just after picking time, that they are unprofitable varieties to grow.

The processes involved in the abscission of shoots and leaves are fairly well known, but the causes that lead up to the initiation of the process of abscission are not so clear. It is highly probable that there is no one specific cause operative in every case, but that there are a number, any one of which may begin it. The young shoots of the bush fruits have, like leaves, a specialised region near their attachment to the parent branch. Although present, this special growing region at the base of the shoots does not normally become active, but under certain conditions growth starts and as a result the branch is cut off by a special layer of cells, and sooner or later the branch falls. It appears that for some reason when shoots and leaves are abscissed, the centres of food consumption are changed and this special region begins active growth. Shoot abscission such as that here recorded has been observed by a number of observers

FIG. I

Showing ball and socket joint made by abscissed shoot and parent branch.

working with forest trees. They find it most prevalent during a wet period that follows an early spring drought. Continuously wet years show little shoot abscission. Foresters have also noted that a year which is notable for a large amount of shoot abscission almost invariably initiates a good seed year. In other words, twig abscission is most prevalent in dry years.

This would suggest that, until further information is available, in dry years fruit growers would be well advised to give particular attention to cultivation so as to induce continuous growth if possible. This will not only lessen the risk of " blowing out " but will give more potential fruit wood for the following year, and will certainly increase the disease resistance of the bushes.

The writer is indebted to Mr. Marsh, who drew his attention to this matter, and who collaborated in making the field observations and notes.

A SURVEY OF STRAWBERRY PLANTATIONS IN ENGLAND (1926-28).

By L. N. Staniland.

The survey of strawberry plantations in England summarised herein was carried out at the suggestion of Mr. J. C. F. Fryer, M.A., of the Ministry of Agriculture and Fisheries. Although a very considerable amount of knowledge of the causes of the various types of abnormal strawberry plants had been amassed, no complete survey had been made since such information was to hand and the extent and importance of the various troubles were not known. The object of the survey, therefore, was to determine, as far as possible, what were the serious troubles of the strawberry throughout the country and the extent to which each was of importance in the various districts.

Farms were visited as far as possible during late spring and early autumn, as past experience has shown that strawberries are most satisfactorily judged by inspection during these periods.

At each farm information was obtained as to the presence and prevalence of the various types of troubles, together with information as to the vigour of healthy plants, methods of selection of runners, cultural methods and any other information which could be obtained and which had a bearing on the case. Over 100 farms were visited, and space does not permit of detailed reports on these being included.

As the result of work carried out at Long Ashton Research Station and in the field, the major troubles of strawberries have been classified under six types, and in the present survey this classification is used. (Previously seven types were recognised, but further work led to the elimination of Type VI, since it was found to be a late stage of either Type II or Type V).

For convenience in the reading of the report a list of the types of abnormal plant is given below, together with short descriptions of each type and its cause where it is known. The survey was concerned principally with these types since it was realised that, though there are many other troubles of the strawberry, the serious failures were due to the prevalence of one or more of the types listed below.

TYPE. I. "DAMAGED CROWN."
Known to many growers as "Miffy" plants. Plants are blind in the first year and have long thin petioles bearing coarse margined leaves. In the late spring the general colour is often somewhat red, but later this turns to a dark bluish-green.

The crowns are numerous, weak and spaced. In the second year such plants fruit in the normal way.

Cause—Crown damage.

TYPE II. "SMALL-LEAF."
Plants flower rather profusely but the flowers are weak and the fruits poor. The petioles are short and thick. Apart from a tendency to yellowing, the leaves are small but normal in character. The crowns are numerous, weak and dense, and the whole plant has a much flattened appearance.

Causes—Damage to developing roots by careless hoeing* in late summer; or damage to the properly developed root system in the autumn, winter or spring by waterlogging or drought. Slugs and leather jackets may also cause "Small-leaf" by damaging the roots.

TYPE III. "CAULIFLOWER DISEASE."
Plants are frequently blind, but where flower is produced it is always much deformed, often to the extent of causing it to assume the appearance of a vegetable cauliflower. The petioles are short, thick and much tapered and vary in colour from beetroot-red to a pale bluish-green. The leaves are much reduced and sometimes almost absent, but are always deformed.

Cause.—Circumstantial evidence points to the eelworm, *Aphelenchus fragariae*, as a possible cause but this has not definitely been proved.

TYPE IV. "RED PLANT," "RED LEAF," OR "RED LEG."
Plants are blind or partially blind. The petioles are sometimes short as in Type III., but are more often long. They are tapered and are in some varieties (notably Royal Sovereign) beetroot-red in colour. Where this red colour is present it does not often persist long after May or early June. The leaves are reduced and deformed with a coarse margin. The margin often has no serrations present.

Cause—From circumstantial evidence only, *Aphelenchus fragariae* is a possible cause. There is considerable evidence to suggest that "Red Plant" and "Cauliflower" diseases may be different forms of the same disease.

TYPE V. "APHIS PLANT."
Plants flower rather profusely, but the flowers are weak and the fruit poor. The petioles are short and thick. The leaves are small, much yellowed, crinkled and cupped. The crowns are numerous, weak and dense and the whole plant has a much flattened appearance.

Causes—This type is due to the attacks of the strawberry aphis (*Capitophorus fragariae*), the symptoms being produced in the period from just after the picking of the fruit until the end of the autumn. In the following spring the aphids leave affected plants and migrate to healthy ones. The affected plant is then difficult to distinguish from Type II. and remains like that Type, following through the same stages in succeeding years.

It is strongly suspected that Type V. may also be caused by attacks of Red Spider (*Tetranychus telarius*).

TYPE VI. "PATCH."
This type has for its distinguishing characters those of Type II., Type V., or a combination of both types, with the addition of dead crowns.

Causes—It now seems fairly certain that in the majority of cases, Type VI.

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* By careless or bad hoeing is meant that, in hoeing, soil is pulled away from the plants and that actually damage to the roots is often caused at the same time. Careless hoeing soon after picking results in death of the tips of the developing primary roots. By good hoeing is meant hoeing definitely surface in character.

is merely a late stage of Type II. or Type V. In other words Type VI. may be regarded as a dying plant of those types. There is, however, evidence that in some cases such a soil factor as a local nutrient deficiency is responsible.

Type VII. Has provisionally been given the name of "Sudden Wilt." The plant wilts rapidly, usually about the time when the fruit is nearly fully formed. Subsequently the plant dies, or becomes a "small leaf" type of plant (Type II). Very few cases have occurred and these have been in notably wet years.

Cause—Examinations by the Department of Mycology have led to the view that it is unlikely that fungi are concerned. The cause would seem rather to be some form of localised waterlogging and may in the future be referred to Type II. Type VII. can also be produced by the attacks of root-feeding insects such as Melolonthid and Curculionid larvae.

Summaries for the Various Districts.

Southampton District.

The main trouble in this district is Strawberry Aphis, and is principally experienced with the variety "Royal Sovereign." The variety "Mdme. Lefebvre" is being planted in increasing amount since the growers find that it "stands well." This good "stand" is certainly owing to the fact that it is unaffected by aphis. The earliness of this variety, the fruit of which is not of high quality, tends to cause a glut of fruit about the time that the "Sovereign" fruit is commencing, with consequent poor prices for the latter.

Selection of runners is on the whole fairly good. Most of the growers appear to realise the need for good selection of runners, but do not always know the best methods to employ. A good deal of improvement on these lines is possible, and would be greatly to the advantage of the growers.

With certain exceptions the growers practice good cultural methods.

Types III. and IV. are present to a slight extent throughout the district, but are not generally the cause of serious loss to the growers.

Kent.

(*a*) *Swanley District.*

Practically all the trouble experienced with strawberries in this district is due to Strawberry Aphis, which is common and widespread.

Strawberry growing has been carried on in this district for a very long time. Growers in this locality, as would be expected, thoroughly understand the growing of strawberries. Selection methods are good, but could be improved still more with advantage. Cultural methods with certain exceptions are good. "Red Plant" and "Cauliflower" diseases are not common and are not responsible for much loss.

(*b*) *Maidstone District.*

Weak stocks and poor methods of selection are responsible for a great deal of the trouble in this district.

Aphis is not nearly so prevalent as in the Swanley district. Many growers have little or no aphis present on their strawberries. Where this is the case the plants are normal but weak, except in those instances where the cultural methods are wrong, when the plants are poor. Such cases were, however, few.

Selection of runners is on the whole not so well carried out as in the Swanley district, and improvement on these lines is very necessary. "Red plant" and "Cauliflower" disease are also more common than in the Swanley district.

(*c*) *Ash District.*

Aphis is practically the only serious trouble which is present in this district, and its control would immediately benefit the growers. Aphis is fairly well distributed and, where this is the case, "small leaf" is common.

"Red Plant" and "Cauliflower" diseases are not common.

Cultivation and the selection of runners are good in this district and, where aphis is not present, strawberries are looking well and "standing" profitably, in some cases for long periods. A bed of "Royal Sovereign" plants in their tenth year was seen, also "Royal Sovereign" and "Sir Joseph Paxton" nine and eight years old respectively. All the above mentioned old beds of strawberries were looking perfectly healthy and were still producing profitable crops.

Worcestershire.

Aphis is present generally throughout the area and is the most serious trouble with which strawberry growers have to contend. The variety "Stirling Castle," which used to be grown considerably more at one time than now, is particularly badly affected, even more so than "Royal Sovereign." The variety "Bedford Champion" is not affected.

In particular, the variety "Bedford Champion" is grown in certain districts near Evesham, and is in a very poor condition. The poor condition of the plants is due to incorrect selection and cultural methods. In addition to damaging the roots of the plants by incorrect hoeing, the growers in this district make a practice of digging deeply close to the plants in the late autumn.

Types III. and IV. are fairly common in the county, but they are found infrequently in the variety "Bedford Champion."

Hereford.

Selection of runners in Hereford is on the whole good. In parts of the county cultural methods are poor, particularly among some of the larger growers, where attempts are made to grow more strawberries than can be properly attended. "Red Plant" disease is present, but is generally slight. "Cauliflower" disease on the other hand is rather commoner here than elsewhere, particularly in the variety "Sir Joseph Paxton." Aphis is not common generally in the county, but occurs in some areas in fair numbers, particularly in the variety "Stirling Castle," on which some damage is caused.

Cheddar District.

The principal variety grown in the Cheddar district is Royal Soveriegn, and the chief trouble in the district is the generally poor stocks of this variety which are grown there. Methods of selection of runners are very poor, resulting in widespread trouble from "Red Plant." Those growers who can afford to do so are buying in stocks of the variety Madame Kooi, but aphis is especially bad on this variety and this course of action is most unlikely to give any lasting benefits. Those who cannot afford to buy in fresh stocks of plants are finding the situation very trying. Enquiry seems to point to the fact that very few stocks of Royal Sovereign have come into the Cheddar district for many years.

Considerable improvement is necessary as regards cultural methods. Hoeing is often careless and a great deal of damage is done by the practice of deep-digging close to the plants.

Aphis is rapidly increasing and has in many cases caused considerable harm both to "Royal Sovereign" and "Madame Kooi"; trouble with aphis is particularly likely to be experienced in the future on this latter variety. A few growers have planted out the variety "Madame Lefebvre," and these are unaffected by aphis, as in the Southampton district and elsewhere.

Chlorosis occurs in various parts of the district owing to the high percentage of lime in some of the soils, but this cannot be said to be one of the major troubles.

Serious losses of fruit due to the attacks of Ground Beetles are of frequent occurrence in the district. The distribution of the insects is very patchy.

Gloucester.

Comparatively few strawberries are grown in Gloucestershire, but, judging from those which have been examined, poor cultural methods, indifferent selection of runners and aphis are seen to be the principal causes of the troubles in this county.

Tamar Valley District.

Strawberry Aphis is very common and evenly distributed and is, without doubt, responsible for a large proportion of the trouble in the Tamar Valley.

" Patch " is very common, as might be expected, for the name " patch " apparently originated in this district. While there seems to be some evidence that soil factors may be responsible for " patch " in some instances, it is clear that a large proportion of it may be attributed to the effects of aphis attack and of poor cultural methods. It is probable that aphis is the more important cause.

As already stated, cultural methods are poor, particularly hoeing. A common feature of the district is that plants are frequently grown on slopes and, where this is the case, soil is often pulled away from the lower side of the plants. This results in a poor root system, the plants only developing new roots on the upper side. Such plants fall under the heading of Type II. (" small leaf ").

" Cauliflower " disease is present but not to a serious extent.

" Red Plant " is common and in some cases is responsible for considerable loss.

Wisbech District.

Selection and propagation of runners in this area are notably poor and the prices paid for runners are often so low that it is evident, by considering the price alone, that little care is taken. Runners are usually allowed to root haphazard, some attempt at selection often being made when they are lifted.

Cultural methods are exceptionally poor, considering the district as a whole. Growers are much given to bad hoeing and to deep working close to the plants in the late autumn. The system of " matted rows " is much practised and plants grown on this system are always markedly inferior to plants grown on the single plant system. Up to the first fruiting period the plants are grown singly in the row. When runners are produced a proportion of them are " laid down " in the rows so as to fill them up and produce a strip or " matted row " of plants. In the course of cleaning these rows the roots of plants frequently become exposed, and it is difficult to replace the soil, both around those plants in the centre of the rows, and also to more than one side of the surrounding plants, even supposing that the grower desired to do this. In " matted rows " in their first year, i.e. rows containing 2-year-old plants with runners laid between, which were taken from the plants in the maiden year—it is frequently seen that a large proportion of the 2-year-old plants have missed a root-forming period. These

plants, as has already been shown, develop into Type II. (" small leaf ") plants. Those runners " laid down " in the first year develop the same symptoms the year after the parents show them.

The weight of the crop obtained is sometimes moderately good. This, however, instead of being the result of a heavy crop on a small number of strong plants, is that of a light crop on a large number of weak and abnormal plants.

" Cauliflower " disease occurs, but not commonly.

" Red Plant " is present to about the same extent as in most other districts, but the distribution is uneven.

Strawberry Aphis is fairly evenly distributed over portions of the area and a number of cases have been seen where it is responsible for serious damage.

Aphis, however, does not appear to be of such importance in the Wisbech district as elsewhere. It would seem that Red Spider is probably of considerably greater importance. Red Spider can produce a " small-leaf " type of plant, but at present it is not known whether or not this " small-leaf " condition remains or whether the plant recovers.

" Patch " occurs commonly both as isolated " patch " plants and in patches in two, three and four-year-old beds, as in other districts.

General Considerations with regard to the Troubles among Strawberries.

Purity of Stocks.

In all the districts visited stocks were seen which were much mixed. In many cases commercial varieties were present as rogues, i.e. Laxton often found as a rogue among Sir Joseph Paxton ; The Duke among Royal Sovereign and Noble among Sovereign. (In the last case the mixture of varieties was referred to by the growers as a new variety, to which the name Goldfinder had been given ; the growers appeared to be unable to distinguish the two definite varieties, familiar to them, once the mixture had a fresh name given to it).

In addition to commercial varieties appearing as rogues, other rogues, known to growers as " wild plants," were commonly seen. These rogues may be non-fruiting, or if fruit is produced it is usually of an exceedingly bad flavour. Such rogues occur, for example, in the varieties Stirling Castle and, to a lesser extent, in Sir Joseph Paxton. Some of the " wild plants " produce very large numbers of runners, and if care is not taken in rogueing them, the percentage of " wild plants " in the stock increases very rapidly.

Vigour of Stocks.

There is no doubt whatever that the vigour of the stocks of strawberries throughout the districts is much below the standard of that before the war. Of great importance is the fact that the most vigorous stocks of plants are in the hands of the small growers. The larger the scale on which strawberries are grown the poorer they tend to be. This suggests that strawberries cannot be properly attended to on a large field scale and that the cultural methods extant in such cases are unsuited to the habit of the plant.

The above remarks refer to healthy, normal plants. Where such a pest as strawberry aphis is present the small grower suffers equally with the larger grower. Since strawberry aphis, so far as is known, first appeared in this country in 1912, and taking into consideration the fact that where aphis has severely damaged plants in their first year the runners are very poor, the theory immediately suggests itself that aphis may have played a large part in the deterioration of the stocks of strawberries in this country. To support this theory it may be seen in the various districts that those varieties which exhibit either a high degree of resistance to aphis, or immunity from aphis are on the whole in a generally more vigorous condition than the other varieties. The above does not, however, apply where such varieties are being grown in districts where cultural methods or methods of selection are particularly careless.

Another important cause of the weakening of stocks is undoubtedly the lack of care taken in the selection of runners. Here again this explains why the small growers have the more vigorous stocks. While the small grower usually carries out such work himself, and as a rule takes considerable care, the larger grower complains that labour is too dear for him to consider any special system in the selection of his runners. The small grower will often take limited first runners from deblossomed maiden plants, after the parents have been thoroughly rogued at flowering time. The large grower may often allow unlimited runners to root from fruited maidens, women being sent to pick out the best. Such women are usually poor judges of strawberry runners. The large grower usually attempts to rogue the parents as well as possible, but it is not to be expected that the ordinary labourers on the farm, though they can usually judge their vigour, can be capable of deciding which plants are healthy.

The falling off in vigour of stocks may also be due to some extent to very extensive planting after the war. Runners were scarce and growers could not be very particular in their choice of plants,

so long as they had determined that a certain acreage was to be planted in any one period.

It is important, in relation to these considerations, that there has been a definite tendency of late years for strawberries to be grown on a larger scale, per grower, than was customary in the past.

There are stocks of the various varieties existing to-day in as vigorous a condition as their predecessors, as far as can be determined. This suggests, strongly, that the lack of vigour in most stocks is not due to the stocks having become "worn out" by constant vegetative reproduction, but that it has been consequent to the treatment they have received and the diseases and pests from which they have suffered over a period of years. This particularly applies to those "troubles" of the strawberry which are of more recent occurrence. Investigations in connection with this aspect of the problem seem to verify the above suggestions, but, as the vigour has been lost, so can it be recovered by better treatment, and the control of diseases and pests.

It has been stated by certain growers that two especially large drops in the vigour of strawberries occurred in the seasons 1911 and 1921. Both these years were outstandingly dry. It is known that, whenever a season is notably dry, growers frequently point out the fact that their plants are obviously suffering to varying extents from such conditions. The plants may not be actually dying and may appear quite healthy, though lacking the vigour which is expected of them. The taking of runners from such plants should not be carried out, but this unfortunately is too frequently the practice. If any conditions, such as drought, impair the vigour of the plants, runners should not be taken. The non-observance of this rule may be responsible to some extent for the gradual reduction in the vigour of strawberries. There are no records as to whether aphis, which might have been an additional factor, was particularly prevalent in 1921. It is, however, fairly certain that the species involved (*Capitophorus fragariae*) was not present in any large numbers in 1911, as its description was first given in 1912, when it was discovered in a greenhouse. In addition, aphis seems to prefer hot moist conditions rather than those which are hot and dry.

Relative Importance of the Various Types of Trouble.

Type I. "Damaged Crown."

Type I. may be found to some extent in the majority of the strawberry fields in all the districts. It is largely due to careless hoeing, damage by horses or an occasionaly attack of slugs or

leather-jackets in small numbers. In only a few instances have cases been seen where serious loss was caused, when severe attacks by leather-jackets were responsible. Type I., therefore, as a general rule, must be considered as a minor trouble.

Type II. "Small-leaf."

In districts where strawberries have been grown for some years and where the size of the holdings is still relatively small, the growers seldom cause injury to plants by careless hoeing, or by deep cultivation close to the plants in the autumn or spring. They generally realise that surface cultivation only should be carried out in the region of the plants. In those districts where strawberries are grown on a large scale or where small inexperienced growers are situated, there is much more trouble from these causes.

Type II. must be classed as a major trouble, but it should be realised that it depends greatly on the class of grower, the scale on which he is growing strawberries and the experience which he possesses.

Type II., due to water-logging or drought, bears no particular relation to the class of grower, except in so far as his soil or general conditions, and his ability to ameliorate these, are directly connected with it.

As described later in this report, an attack of aphis can cause cultural methods, which were correct before the attack, to become incorrect after aphis has affected the plants.

Growers, to whom it is suggested that their cultural methods are incorrect, frequently reply that their methods have not changed and that strawberries grew better years ago, with the same cultivation as they use at present. As the result of frequent discussions with growers on this subject, the conclusion arrived at by the writer is that such ideas may be accounted for in the following ways, one or more of which may be involved :—

(*a*) The grower is mistaken and old cultural methods differed from those he uses at present.

(*b*) Labour is less skilled now than it used to be.

(*c*) The vigour of the stocks, on the whole, was so much greater that the plants could survive more ill-treatment than those of the present time.

(*d*) The grower believes that the strawberries he grew in the past were very many times better than the most healthy and vigorous plants that he now has.

On enquiry it is found that the crops per acre which are said to have been obtained in the past can only be considered as grossly over-rated. Admittedly, better crops were obtained in the past than at present, but it seems impossible that they were superior to the extent claimed by some growers.

Many growers are now so disgusted with the cultivation of strawberries that they tend to have distorted memories of the crops they used to obtain.

These growers who still have relatively good strawberries and know how to grow them well have usually no such exaggerated experiences to relate.

Type III. "Cauliflower Disease."

Type III. can only be considered a minor strawberry trouble, even in the case of the variety Sir Joseph Paxton, which is more seriously affected than other varieties. There are a few instances where Type III. has caused significant loss, but in such cases selection of runners and the rogueing of runner beds are conspicuously poor, or absent.

Type IV. "Red Plant."

In the early days, when the various types of strawberry trouble had not been distinguished, all weak or abnormal plants were classed as "red plant," "red leg" or "red leaf." Growers, however, considered "cauliflower" disease to be a separate type of abnormal plant.

Ballard and Peren, working at Long Ashton, arrived at the conclusions that there was a correlation between "red plant" and "cauliflower," that they were different forms of the same disease and were due to eelworm. They also turned their attention to "small leaf," and concluded in this case also that eelworm was the causal organism. This work strengthened still further the convictions of the growers that eelworm was the principal cause of the trouble in strawberries and led them further to class "small leaf" under the broad heading of "red plant." Now that two forms of "small leaf" (Types II. and V.) are recognised and separated from "red plant," it is found that true "red plant" is by no means as common as was supposed. Though "red plant" has still to be considered as one of the major troubles, cases where really serious losses are due to it are by no means of general occurrence. Such instances, as in the case of "cauliflower," are only found where a grower takes little of no care over the selection of runners and the rogueing of parent plants or where a stock has been bought in from such a grower.

Type V. "Aphis Plant."

Type V occurs in all districts very commonly on all those varieties which are susceptible to attack by aphis.

Susceptibility of Varieties to Aphis Attack.

There are stocks in all districts where susceptible varieties are not attacked by aphis and these stocks are healthy where they are not suffering from other troubles. It is not yet known why some stocks in badly affected districts should be free from aphis. Their freedom is certainly not due to having been sprayed. The following list shows the degree to which some of the varieties are attacked by aphis :—

Susceptible.

Sterlingworth.
Mdme. Kooi.
Stirling Castle (Vicomptess Hericart de Theury or Garibaldi).
Laxtonian.
Royal Sovereign.
The Duke.
Laxton's King George.

These are placed approximately in order of susceptibility, commencing with the most susceptible variety, which is Sterlingworth.

Moderately Resistant.

Frith.
Sir Joseph Paxton.
The Laxton.
Givon's Late.

Highly Resistant or Immune.

Sir John Ruskin.
Lord Overton (Dumbarton Castle).
Climax.
Aberdeen Standard.
Bedford Champion.
Marshal Foch.
Sturton Cross.
Mdme. Lefebvre.
Tardive de Leopold.

The varieties in the last group are classed together as highly resistant or immune since it has not been found practicable to separate them into two groups. Although in no case has any of the above-mentioned highly resistant or immune varieties ever been found to exhibit the symptoms of aphis attack, aphis has been observed in small numbers on some of them. It is those varieties in the last

section of the above list of varieties which are, by far, most frequently found to be healthy; when unhealthy, their condition has never been found to be due to aphis but to other of the causes already mentioned. This fact lends additional support to the evidence already obtained, as the result of the examination of varieties susceptible to aphis, viz., that the aphis, *Capitophorus fragariae*, is by far the most serious trouble of strawberries throughout the country at the present time. Since it is the varieties in the sections of the list comprising the susceptible and moderately resistant varieties which are chiefly grown commercially, this would be expected.

The Normal Course of an Aphis Attack.

The normal course of an attack as seen in all the districts is as follows :—

Runners produced by aphis infected parents usually become, in time, infected. The typical small leaf symptoms sometimes appear while the runners are still attached to the parent plants. In any case a certain proportion will show the small leaf symptoms by the end of the first autumn in the year of planting.*. Frequently a proportion of these will exhibit excessive and premature lateral crown formation.

These plants will retain their small leaf habit for the remainder of their lives, and in fact, as is shown later, become more badly affected with this condition as their age increases.

Those plants which so far remain healthy become infected with aphis to varying extents in the spring, the time depending partly on whether there is a migration of aphis. The plants previously attacked now invariably have little or no aphis present on them for the remainder of their lives. It seems probable that this is due to a greatly increased starch content of the plant, probably as a direct result of the aphis attack, which renders the food supply of the aphids unsuitable to their needs. Aphis is seldom found on Type II. "small leaf" plants, the explanation probably being for similar reasons. In any case the aphids leave the plant they have affected, which habit results in a very rapid spread of aphis throughout the bed of strawberries, fresh cases being produced on a proportion of the remaining healthy individuals in the autumn of each year. Generally speaking, in an average bad attack of aphis, three years is sufficient to result in infection in all the plants and the death of the majority. As many growers often do not

* It is assumed in this case that runners are planted in August or September. Where runners are planted in the spring they have an even greater chance of being affected, particularly if they remain over winter in the runner beds.

ask for advice until this stage has been reached and since in the fourth year practically no aphis is to be found on any of the plants, the information that the trouble is due to aphis is often received with great suspicion: the grower is frequently positive that his plants had never had aphis. Enquiry has shown that for a grower to consider that his plants had an aphis attack, they must be smothered with the insects. Experiments at Long Ashton have shown that comparatively small numbers of aphis are quite sufficient to produce the symptoms.

Over-Wintering of C. Fragariae.

Examination of aphis in the districts at different times of the year have failed up to the present to bring to light any evidence of an egg stage. The conclusion therefore is that the aphis over-winters entirely as a wingless viviparous female on the strawberry. Very severe weather conditions do not appear to affect the over-wintering of the pest.

The Relation between Attacks of Aphis, Cultivation and Type II.- Small Leaf.

Cases are very frequently seen where a grower, who is a careful cultivator, has apparently a number of "small leaf" plants answering to the description of "Type II. -small leaf." These plants appear as though they have been partly raised out of the ground and, if they are fairly old cases, the remains of root systems which have failed to develop can be seen. Examination of the healthy plants frequently shows that in no case has the soil been pulled away from the plants and that they have missed no root forming period.

Records taken over several seasons at Long Ashton show that aphis-affected plants produce excessive numbers of weak crowns which grow relatively high in the air and that such crowns are formed in the year of the aphis attack. Developing roots on these crowns, besides being very weak, are produced at a point some distance above soil level, with the result that they cannot usually reach the soil before the tips are killed. Having missed a root formation period, therefore, the plant continues its life as a case of Type II. "small leaf" and dwindles gradually until it becomes a "patch" plant and finally dies. Type II. "small leaf" in this case is due to the upsetting of a grower's careful cultural methods by an attack of aphis on the plants. It would be supposed from theoretical reasoning that if soil were raised higher round aphis-affected plants that they might be prevented from further deterioration, though it seems impossible that they could be improved. These possibilities have not, however, been tested.

Type V I. "Patch."

Although in the first instance "patch" was considered to be found principally in the Tamar Valley, the survey shows that it is generally distributed throughout the strawberry districts and that often quite as serious cases are to be found there as in the Tamar Valley. It frequently is due to the final effects of aphis attacks causing isolated "patch" plants and groups of "patch" plants forming areas of varying sizes. It should, however, be understood that the stages are as follows, considering for example an autumn planted runner :—

1st Autumn ..	.. Healthy runner planted.
1st Spring ..	.. Infected with aphis.
1st Picking Time	.. Symptoms of aphis attack commencing to appear. New root system commencing to form.
2nd Autumn ..	.. Typical "small leaf" symptoms produced, together with an excessive lateral crown formation. The root system which has, by now, been produced, is poor. The excess lateral crowns have failed to root. Plant now one year old.
2nd Spring ..	.. Little or no aphis present. "Small leaf" persists, but the leaves have not the typical cupping and crinkling caused by aphis. Plant now has the symptoms of Type II. "small leaf."
2nd Picking Time	.. Root formation should again be taking place, but, owing to the condition of the plant during the last root-formation period (2nd Autumn), no roots develop. A plant which is therefore identical with a Type II. plant, has suffered that which would cause a healthy plant to develop the symptoms of Type II. "small leaf." From now on, therefore, the plant dwindles in size very rapidly.
3rd Autumn ..	.. Occasionally by the end of the 3rd Autumn some dead crowns may be present in which case the plant would be called "patch." Plant now 2 years old.
4th Autumn ..	.. Plant is nearly always a marked case of "patch." Sometimes the plant has died.
5th Spring or Autumn	.. Plant usually dead.

Soil Factors.

It is clear from the survey that soil factors causing failure undoubtedly exist in all the districts. They are, however, only responsible for a small portion of the existing troubles. The impression obtained is that these soil factors do not merely react adversely on the strawberry but affect any crop on that piece of land. For example, a "patch" in the variety Stirling Castle in Worcestershire appeared in the same place in peas following the strawberries and in groundsel and other weeds when the ground was fallowed. Chlorosis is also present in some districts, but is not confined to strawberries. It should be noted, however, that the varieties Leader and Sir Joseph Paxton are particularly susceptible.

RECOMMENDATIONS :—

I. *Improvement of Stocks.*

Included under this heading is the reduction of the amount of "red plant" and "cauliflower" disease. The following recommendations are of first importance :—

(*a*) Growers with weak stocks of plants should purchase good stocks to replace them ; good stocks of plants will frequently be found in the hands of the smaller growers, but, in any case, stocks bearing the certificate of the Ministry of Agriculture should be purchased in preference to those which have not been inspected. Growers should be prepared to pay a good price, where the production of such runners has been carefully and correctly carried out.

(*b*) To maintain healthy stocks of plants it is essential to give special attention to the following points relating to propagation :—

(i) Sufficient maiden plants, to produce the number of runners required, should be "set aside" as parents.

(ii) Such "parent" plants should be carefully rogued for "red plant," "cauliflower disease" and any weak or otherwise unsatisfactory plants.

(iii) The "parent" plants should be de-blossomed. Plants should not be expected to produce both runners and fruit. If plants are planted early in the autumn and general conditions are favourable, they will produce profitable crops of fruit or good runners, but cannot properly produce both, without detriment to the quality of the runners produced.

(iv) Runners should not be produced in excessive numbers. It is advisable, where possible, not to allow more than five runners to be produced by each parent plant. Runners should be "stopped" after the first runner plant has formed. If feasible, hand-laying with wire hooks or stones may be carried out with advantage. Succeeding runners should be removed.

II. *New Varieties.*

The question of the need for new varieties has been raised, in conversation with growers, many times.

There is a clear demand for new varieties of strawberry which will be highly resistant or immune to strawberry aphis and at the same time combine some of the commercial characteristics of several of the susceptible varieties now being grown. For example, most of the resistant and immune varieties known at present are late fruiting, and of only medium quality. Mdme. Lefebvre is early and immune, but has not the quality of Royal Sovereign. Work in connection with the breeding of aphis resistant varieties is now in progress at this Station.

III. *Cultural Methods.*

Much of the condition of strawberries is due to failure of the plants to make new roots at picking time as the result of soil being being pulled away from the crowns during hoeing operations : or the root system is damaged, after its formation, by deep cultivation close to the roots during late autumn or spring.

Growers should, therefore, bear the following points well in mind :—

(i) When cleaning beds after picking, avoid pulling soil away from the region of the crowns.

(ii) It is advantageous slightly to earth up the plants, immediately after picking.

(iii) At all times carry out surface cultivation only near the plants. Deep digging or other deep forms of cultivation may be carried out in the alleys if considered desirable, but on no account should such operations be carried out in the immediate vicinity of the plants.

In addition to the above-mentioned points, growers should realise that the period immediately following the picking of the fruit is an important one and that the operations carried out at that time may have a very considerable effect on the crop of the following year. It is, however, clear that even when this is realised the final fruits of such knowledge can only be obtained if the growers will take definite steps to instruct their labourers. Numbers of cases have been seen where a grower is fully conversant with the correct methods of cultivation, but his labourers in the field can nevertheless be seen carrying out the work incorrectly. Demonstrations to the labourers would undoubtedly improve this state of affairs.

IV. *Aphis.*

It is clearly necessary for strawberry growers throughout the country to control aphis.

The dipping of runners, before planting, in nicotine and soap solution should become a routine measure. The dip consists of ½oz. of 95-98% nicotine to 10 gallons of water, to which sufficient soap has been added to form a lather. Growers should also concentrate on spraying or dusting the plants immediately after the fruit is picked with nicotine and soap wash (of the same strength as the dip) or a good contact insecticide dust.

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Bibliography.

A full bibliography of the work on strawberries will be found at the end of the article dealing with "Strawberry Investigations at Long Ashton," by E. Ball, C. E. T. Mann, and L. N. Staniland, which appeared in the September and October issues of the Journal of the Ministry of Agriculture, 1927.

STRAWBERRY VARIETY IDENTIFICATION.

INTERIM REPORT.

BY

J. G. MAYNARD.

During the past eight years a considerable amount of attention has been paid at Long Ashton to problems relating to strawberry culture. The reason for this has been the fact that commercial strawberry growing has ceased to give the returns per acre commonly obtained only fifteen or twenty years ago. This reduction in returns is not only accounted for by increased cost of labour, but the crop weights per acre usually returned to-day are only about half those obtained earlier in the century. Attention has been drawn by various writers to the pathological aspects of the present trouble, and to the cultural requirements and normal development of the strawberry plant. Special attention was paid by Ball at this Station to strains of strawberry within one variety, and he also drew attention to the common prevalence of rogues in commercial plantations.

The object of the present investigation is to provide a means of identifying and classifying varieties of strawberries by the botanical characters of the plants. The selection of characters for use in this connection must be based on the relative constancy of such characters : a number of characters, which at first sight would appear to be the most obvious and easy ones to use, have been found in practice to vary considerably with climatic or manurial conditions, as for instance intensity of colour in various parts of the plant or details of leaf shape.

Petiole Hairs.

The first and most important character for classification purposes is the type of hairiness of the petiole. In the main, the hairs are of two types, " outright " or standing roughly at right angles to the petiole (Figure 1), and " upright " or lying closely against the petiole (Figure 2) and pointing upwards. In addition to these two types, there is apparently a tendency in certain varieties for these hairs to point downwards ; and there are also varieties with

very densely or very sparsely haired petioles. It is not proposed to introduce these latter points into this paper as further confirmatory evidence seems necessary, and also it does not seem desirable at this point to draw up tables of a possibly complex nature.

Similar hairs to those on the petiole occur on both the stolon and the flower stalk, but apparently the type of hair, whether "outright" or "upright" is not necessarily the same on any one variety, say on petiole and stolon or petiole and flower stalk. If this particular point is substantiated, it will be of great value in identification, but here again further confirmatory evidence seems essential as the point was only noticed late in the 1928 growing season.

Stipule Colour.

The second character suitable for use is the stipule colour. There are many degrees of colour intensity, but two divisions only are proposed at present :—"green" or "white green" without trace of red turning brown with age ; and "coloured," various intensities of red ; where colouring is very intense a special note has been made. It may be remarked in passing that the size and shape of the stipule does not appear to be of much value as a general character but that, for confirmatory evidence, these may be useful.

Foliage Colour.

The third character suitable for consideration is very much more difficult than the two first to define for classification purposes or to use. Anyone relatively familiar with strawberries will know the considerable difference in foliage colour between, say, the very dark green Sir John Ruskin and the lighter green of The Duke, but to attempt finer grouping of foliage colour would appear of questionable value on account of the difficulty of discrimination. For this reason two main groups of foliage colour only are made at this stage, "dark green" and "ordinary green."

Certain varieties, for instance Keen's Seedling, have a noticeably "light green" foliage ; and a third group could be formed by such varieties. However, so few of these varieties are included here that only a special note is made of them under the "ordinary green" heading.

Varieties grouped in accordance with the above characters are shown in Table I. This first division affords a primary basis for grouping varieties, and is adopted for the purpose of making the later tables less complex.

TABLE I.

Petiole Hairs.	Stipules Red.		Stipules Green.	
	Dark Green Foliage.	Ordinary Green Foliage.	Dark Green Foliage.	Ordinary Green Foliage.
Outright.	*Group A.*	*Group B.*	*Group C.*	*Group D.*
	†Dumbarton Castle	†Aberdeen	Givons Late Prolific	Climax
	†Omega	Favourite Flandern	McMahon	Hibberd's (South Hants)
	Stirling Castle	†Laxtonian		King George
		Lord Grenfell		Leader
		†Madame Kooi		
		Madame Lefebre		
		Noble		
		Oberschlesien		
		†Paxton		
		Royal Sovereign		
		*Stirlingworth		
		Tardive de Leopold		
		†The Duke		
Upright.	*Group E.*	*Group F.*		
	†Aberdeen Standard	Jacunda		
	†Bedford Champion	*Keens Seedling		
	†Sir John Ruskin	The Laxton		

* Indicates noticeably light green foliage.

† „ „ dark red stipule.

Leaflet Surface.

The next character of classification utility is that of the leaflet surface. Only two divisions seem desirable at this stage; to go further would add to the complication. One important point in using this character is that leaves of a standard age should be used; for the present young leaves just fully expanded are considered the most suitable. The two divisions are "leaflet surface corrugated," and "leaflet surface relatively even."

Table II gives the varieties classed in these divisions.

TABLE II.

Group Letter from Table I.	Leaflet Surface Corrugated.	Leaflet Surface Even.
A.	*Sub-Group* 1.	*Sub-Group* 2. Dumbarton Castle Omega Stirling Castle
B.	*Sub-Group* 3. Flandern Laxtonian Madame Lefebre Madame Kooi Noble Oberschlesien Paxton Royal Sovereign Stirlingworth Tardive de Leopold	*Sub-Group* 4. Aberdeen Favourite The Duke The Frith Lord Grenfell
C.	*Sub-Group* 5.	*Sub-Group* 6. Givon's Late Prolific McMahon
D.	*Sub-Group* 7. Hibberd's King George (South-Hants)	*Sub-Group* 8. Climax Leader
E.	*Sub-Group* 9.	*Sub-Group* 10. Aberdeen Standard Bedford Champion Ruskin
F.	*Sub-Group* 11. Jacunda Keens Seedling The Laxton	*Sub-Group* 12.

The underlining of a variety indicates that the character is particularly marked.

In the third table the curvature of the whole lamina, usually consisting of three leaflets, is considered. Both the whole lamina and its leaflets may vary from convex, through flat, to concave. Again young fully expanded laminae are used for this table.

TABLE III.

Sub-Group from Table II.	Whole Lamina Concave.			Whole Lamina Flat.			Whole Lamina Convex.		
	Leaflets Concave.	Flat.	Convex.	Concave.	Flat.	Convex.	Concave.	Flat.	Convex.
A. 1									
A. 2					Dumbarton Castle	Omega		Stirling Castle	
B. 3				Laxtonian			Royal Sovereign	Flandern	Md. Lefebre
				Noble					
				Paxton			Stirling-worth	Tardive de Leopold	Md. Kooi
B. 4	Aberdeen Favourite			Lord Grenfell					Obersch-lesien
	The Frith								
	The Duke								
C. 5									
C. 6								McMahon	Givón's Late Prolific
D. 7							Hibberd's King George (Sth Hants)		
D. 8				Leader				Climax	
E. 9									
E. 10	Ruskin			Bedford Champion	Aberdeen Standard				
F. 11								The Laxton	Jacunda
F. 12									Keens Seedling

PLATE I.

FIG. 1.

FIG. 2.

Other Characters of Systematic Value.

The characters used in the foregoing tables are all such as may be used for identification of varieties over a relatively prolonged period. Characters not so far mentioned which have been examined in a preliminary way and are also useful over a relatively prolonged period are:—

(i) Leaflet shape.

This varies from long and narrow as in Little Scarlet to almost round as in The Duke or The Frith. Here again extremes of shape only are likely to be of value, by far the majority of varieties falling into an intermediate group.

(ii) Hairiness or otherwise of leaflet surface.

Certain varieties such as Sturton Cross are densely hairy on the upper leaflet surface. Here again the same remark as to extremes applies, as in fact it must do almost always; the process of identification being one of elimination.

(iii) Presence or absence of channel in the petiole.

(iv) The general habit of the variety as regards its form of growth; for instance the very spreading Little Scarlet, and the very compact upright Sturton Cross or Givon's Late Prolific.

(v) The tendency of certain varieties to produce four or more leaflets; for instance South Hants Hibberd's King George V.

In addition to the foregoing, certain characters which are only of value in identification for a short period are being observed, viz:—

(I) General flower characters, for example the very large flower of Givon's Late Prolific, the monoecious character of Tardive de Leopold, etc.

(II) Shape and size of calyx.

(III) Usual shape of fruit.

(IV) Position and colour of achenes on fruit.

(V) Colour of surface of fruit, and depth of colour in the flesh.

(VI) The character of the "plug."

(VII) The season for ripening of the fruit and its firmness.

Observations on Varieties.

The list of varieties classified in the tables is very incomplete, while certain varieties included are not well known. The reason

for including the latter at this point is the fact that some are being considered for commercial planting and their distinguishing characters for identification purposes are not yet familiar to many growers.

In addition to the varieties mentioned in the tables notes have been collected on the following :—

Alphonze XIII.	Empress.	International.
Avant Toutes.	Ernest Preusse.	Laxton's Latest.
British Queen.	Fillbasket.	Maincrop.
Duchess of York.	Gandy.	Majestic.
Early Dutch.	Grove End Scarlet.	Marshal Foch.
Missionary.	Reliance.	Pineapple.
Royal Hericart.	Progress.	Scarlet Queen.
Queen.	Senator Dunlap.	Rearguard.
Sturton Cross.		

The following points concerning the identity of individual varieties have been noted during the course of the observations.

1. A small group of varieties consisting of Givon's Late Prolific, Dumbarton Castle, McMahon, Omega, etc., are all very closely alike ; the correct nomenclature within the group for each one is at present quite uncertain.

2. No botanical difference has yet been seen between Royal Sovereign and Laxton's King George V.

3. Hibberd's King George V of South Hants and of Kent are quite distinct, the latter possibly being synonymous with Jacunda.

4. Of the two varieties Aberdeen Favourite and Aberdeen Standard, that described above as Aberdeen Standard seems the better commercial proposition in English strawberry growing areas.

5. Probable Synonyms.

Leader = Kentish Favourite = (Fillbasket of some).
Stirling Castle = Garibaldi = Vicomptesse H. de Thury = (President ?).
Dumbarton Castle = Lord Overton.
Madame Kooi = Juliana.
Jacunda = Amazone = (Kentish Hibberd's King George V ?).
Tardive de Leopold = Spaat von Leopoldshaal.

Summary.

1. This paper is a progress report on strawberry variety classification.

2. Certain botanical characters of the plant of obvious utility for classification purposes are discussed.

3. Preliminary tables are given for 28 varieties, showing their grouping.

4. Certain points with regard to the identifying of individual varieties are noted.

LEAF SCORCH ON FRUIT TREES.*

By T. Wallace.

Part I.

Introduction.

In the Annual Report of the Station for 1921 (1) an extensive account was given of the investigations carried out on "Leaf Scorch of Fruit Trees" at the Station up to that time.

In discussing the results obtained in those investigations, it was pointed out that in every case examined the water relations of the leaf tissues were apparently involved. Leaf scorch appeared to develop under certain conditions conducive to inadequate water supply within the foliage.

In considering water relations in the leaves, the desirability of considering not only loss of water from the leaves by transpiration but available water supply to the leaves by means of root action was emphasised. It was shown that, whilst under certain conditions of water shortage wilting results, apparently under others leaf scorch is produced.

Evidence from pot experiments with apple trees indicated that deficiency of potassium in the nutrient medium was favourable to the development of scorching and cases were cited in which scorch had disappeared from trees growing under field conditions following the application of potassic manures.

Field observations were reported in which leaf scorch had notably decreased following the "grassing down" of affected trees.

In the soil studies discussed it was shown that, where scorching occurred, the soil texture was usually very open and likely to cause summer drought whilst, in a few cases, it was of a peculiar compacted character which was very probably unfavourable to efficient root development.

Cases were also mentioned which indicated that root stock action was of importance in the case of apple trees.

Since the publication of the above paper, work has been continued along certain lines with a view to elucidating problems which arose

* An abridged Form of a Paper published in The J. of Pomol. and Hort. Science, Vol. VI., No. 4, 1928; Vol. VII., Nos. 1 and 2, 1928.

and to elaborating evidence in certain directions which appeared of importance to a wider knowledge of the problem. These studies have been wholly concerned with problems of physiology and nutrition. Certain of the physiological results have been reported previously in two papers by Summers (4) and Mann (3).

In the present paper, the results of some of the nutritional investigations carried out by the writer up to the end of 1926 are given.

Summers (*loc. cit.*) in his paper, discussed certain transpiration phenomena in relation to scorching and reported results obtained in experiments on the interference with the water supply to the leaf. He concluded from these that the scorched leaf results from a rapid breakdown of the water supply to the leaf under conditions of a severe and sudden evaporation pull on the water of the leaf. In the case of wilting the conditions producing drying out are more gradual.

He also examined the production of the characteristic marginal browning which occurs on scorched leaves and concluded that it is in all probability due to the action of oxidising enzymes upon the chromogens produced during the drying out of the leaves. This last point is one which merits special attention. In attempting to controvert the theory that leaf scorch is the result of a drying out process, the argument has been frequently advanced that scorching cannot be the result of such a process, since it often makes its appearance during a wet period of weather whereas no signs of it had been observed during a previous period of hot dry weather. The observations of Summers serve to clarify this point. The drying out process takes place during the hot weather and results in an incipient stage which often passes unnoticed. When the dry conditions subsequently give way to moist ones, oxidase action commences and the brown stage results.

Mann (*loc. cit.*) examined some effects of potassium and calcium starvation on the foliage of apple trees and gooseberry bushes in sand cultures and obtained results which throw light on the action of potassium in controlling leaf scorch.

Working with apples, he showed that deficiency of potassium results in decrease of leaf size whereas deficiency of calcium results in an initial increase in leaf size.

Using gooseberry leaves detached from the shoots, the water content of the leaves from potassium deficient bushes was found to be lower and from calcium deficient bushes higher than that of leaves from bushes fed with a complete nutrient solution.

The rates of water loss from similar sets of detached leaves from these bushes were compared at two different temperatures, 18° C. and 25° C., and it was found that, especially at the higher temperature, the potassium deficient leaves lost water much more rapidly than those from the complete nutrient bushes, whilst the rate of loss from the calcium deficient leaves was slower than from those from the latter bushes.

Finally, the transpiration rates of apple leaves from trees of the series " potassium deficient," " complete nutrient " and " calcium deficient " were compared under conditions of low illumination and of high illumination. Under the former conditions the transpiration rate of the potassium deficient foliage was lower than those of the " complete nutrient " and " calcium deficient " series, which rates were similar, whereas under the latter conditions the transpiration rate of the potassium deficient leaves rose above those of the other two series. Under these latter conditions the calcium deficient leaves showed a lower rate of transpiration than did those from the " complete nutrient " trees.

Mann's results indicate that the leaves of potassium deficient trees have a relatively low water content and that under conditions favourable to rapid transpiration such leaves possess relatively poor resistance to water loss.

Before passing to the description of the results of the present investigations, it will be convenient to refer to results obtained by Hatton and Grubb (2) at the East Malling Station.

These workers recorded the incidence of scorch on a block of apple trees consisting of several varieties on various root stocks and examined the data in relation to root stock types, varieties, pruning, blossoming, cropping and manuring. They concluded that rootstocks exercised very decided effects on the susceptibility to leaf scorch of the scion varieties worked on them. Trees on Malling Type V were extremely susceptible to scorching, those on Malling Types II and VII were also distinctly susceptible whilst those on certain other stocks were relatively resistant.

In their paper, a list of varieties in order of susceptibility to scorch as determined on the Malling plots is presented. Cropping appeared to promote leaf scorch development, whilst pruning seemed to ameliorate the condition. It is pointed out that the pruning effect may be largely or wholly due to decreased cropping which resulted from the treatment. Manuring with dung and artificials reduced the amount of scorch, but it was not clear how the manures had effected the result.

The investigations reported in the present paper fall naturally into three distinct groups and accordingly are dealt with in three sections as under :—

1. Pot experiments with trees and bushes in sand culture.
2. Soil investigations.
3. The control of leaf scorch in the field.

Part II.

Pot Experiments with Trees and Bushes in Sand Culture.

1. *Experiments on Potash Deficiency.*

(*a*) *Experiments with Nutrient Solutions.* Since 1921, pot experiments have been carried out each season in which apple trees, gooseberry and black currant bushes and raspberry and strawberry plants have been grown in sand and fed with the following solutions : complete nutrient solution ; nitrogen omitted ; potassium omitted ; phosphorus omitted ; calcium omitted ; magnesium omitted ; water only. In these experiments, it has been found that leaf scorch is the characteristic symptom of potassium deficiency and that the other treatments effect equally characteristic symptoms on the foliage but that they are quite distinct from leaf scorch. Furthermore, leaf scorch is accentuated by feeding with nitrogen, and trees and bushes can only be grown free from scorching by ensuring a sufficiently narrow ratio of $\frac{\text{nitrogen}}{\text{potassium}}$ in the diet of the plants.

(*b*) *Experiments on the Control of Leaf Scorch by Spraying with Sulphate of Potash.* Spraying experiments were carried out during 1925, 1926, on gooseberry bushes, variety King of Trumps, which had been growing in sand and receiving the nutrient treatment "potassium omitted" since 1922. Each season, prior to the spraying experiments, the bushes used had scorched severely and exhibited all the typical symptoms of potassium deficiency.

For the purposes of the spraying experiments, some representative bushes were selected and half of them sprayed with a 1 per cent. solution of sulphate of potash at intervals of a few days throughout the season, the remainder being sprayed with water on these occasions.

The "potassium omitted" nutrient treatment was continued throughout the experiment and the plants were protected from rain and adequate precautions taken to prevent the spray material from coming into contact with the root systems. In both experiments, leaf scorch was entirely controlled by the potash spray. The results for the 1926 experiment are shown in Table I.

TABLE I.

Observations on Growth and Leaf Scorch.

Date.	K_2SO_4 Sprayed.	Water Sprayed.
April 26th	Foliage excellent	Foliage excellent.
May 8th	Foliage excellent. Leaves larger than in water series.	Leaves dull green and exhibit curling towards under surface.
„ 16th	Foliage and shoot growth excellent	Slight scorch showing. All bushes have smaller leaves and shorter shoots than K_2SO_4 series.
June 6th	do.	Leaves relatively small; dull green colour; show curling towards under surface. Scorch fairly severe.
„ 28th	do.	Scorch severe, all plants.
July 11th	A trace of scorching on a few of older leaves. do.	do.
Aug. 8th	do. A few scorched leaves on three bushes.	Practically every leaf badly scorched.
Sept. 24th	do.	All foliage severely scorched and in crippled condition.
Oct. 16th	do.	Much defoliation and much foliage completely dried out.

2. *Experiments on the Production of Leaf Scorch by Waterlogging and Non-Leaching.*

Since it had been noted that leaf scorch areas in the field frequently coincide with wet soil patches, experiments have been carried out with pot plants in which bad drainage conditions have been simulated by waterlogging the plants and withholding leaching treatment.

The plants used were gooseberry bushes, variety King of Trumps, and these were grown in sand. In the waterlogging experiments, all the bushes were fed with a complete nutrient solution and, in the leaching experiments, the treatments included complete nutrient, omitting nitrogen, omitting potassium, omitting phosphorus, omitting calcium and omitting magnesium.

It was found that leaf scorch may result from waterlogging vigorous plants and that non-leaching results in the suppression of the natural tints and to the general tendency to scorching irrespective of the nutrient treatment.

3. *Experiments on the Susceptibility to Leaf Scorch of Apple Stocks and Varieties.*

An attempt was made to test the relative susceptibilities of various apple root stocks and varieties by growing, in 10″ pots in sand, the unworked stocks and the stocks worked with the various varieties, the trees being fed with a solution deficient in potassium.

The experiment indicated to some extent the relative resistance of the varieties to scorching but the conditions were not suitable for providing information in relation to the stocks.

Part III.

Soil Investigations.

Soil investigations have been greatly extended since the publication of the 1921 paper, the soil conditions in 91 cases of leaf scorch having been examined. They include areas located in the more important fruit districts in the West Midlands and the South Eastern counties and the areas provide cases in which the soils have been derived from rocks of widely different composition. The centres include soils on the following Geological Formations : Clay with Flints, Thanet Beds, London Clay, Chalk, Wealden Clay, Hastings Beds, Lower Greensand, Inferior Oolite, Middle Lias, Keuper Marl, Mountain Limestone, Old Red Sandstone, Wenlock Shale and on areas of Glacial Drift, River Gravel and Alluvium.

It was found, with the exception of one case, that the soils of the scorch centres could be grouped together into three classes, on the basis of texture, permeability to water and conditions of drainage, as under :—

Class I. Surface soil and subsoil (where present) are open textured and conditions are such as to favour free drainage and relatively poor water supply during dry weather.

Class II. The surface soil is close textured, generally a silty loam which may be poorly weathered and overlies a close-textured unweathered subsoil which is impervious to water. The soil may be subject to waterlogging during wet periods where the site is level and is liable to dry out quickly during periods of drought.

Class III. Surface soil and subsoil contain high percentages of clay and the drainage of the area is defective.

The classification shows that the occurrence of leaf scorch at the centres is closely related to unsatisfactory conditions of water supply as all cases may be considered as liable to suffer from excess or deficiency of soil water.

The chemical data obtained on the soils reveal the following points :—

The values for " available " potash are usually low and are never

high ; " available " phosphoric acid shows a wide range and may be extremely high or only low ; the soils may be acid or they may contain either low or high amounts of carbonate of lime.

The salient points regarding the manurial practices at the scorching centres are as follows :—

1. In a few cases manures have never been applied.
2. Where manuring has been carried out, it has been usual to apply " organic " manures containing nitrogen and phosphates, but either no potash or only a small percentage of potash, *e.g.* shoddy, bone manures, meat meal, fish meal.
3. Farmyard manure is generally not available in any quantity and in no case has it been used regularly.
4. Potash manures have never been applied regularly at any centre.
5. Lime has been frequently applied at certain centres and has not been used at others.

The important point regarding the manurial practices is that, whilst nitrogen and phosphates have been regularly applied at many of the centres, there are no cases where potash manuring has been regularly followed.

Part IV.

The Control of Leaf Scorch in the Field.

In considering the problem of controlling leaf scorch in the field, the more important points which must be taken into account are as under :—

1. Susceptibilities of the plants to scorch—including
   (*a*). Class of fruit—whether apples, plums, pears, etc.
   (*b*). Varieties—these vary greatly in susceptibility.
   (*c*). Rootstock effects in tree fruits.
2. Cropping—fruiting is conducive to scorching.
3. Soil conditions—especially in relation to water supply.
4. Points of management—high cultivation is conducive to scorching whilst " grass " tends to check the trouble.
5. The ratio of $\frac{\text{nitrogen}}{\text{potassium}}$ in the plant food.

Manurial Experiments.

Manurial experiments with a view to determining the extent to which scorch can be controlled under commercial conditions by the regular use of potash manures—and in a few cases with dung—were carried out at thirteen centres.

Of these, the soil conditions at ten centres fall into Class I, at two centres into Class III, and at one the soil does not fit into any of the three classes. At seven centres, the experiments were of a very detailed character, records for individual trees and bushes being taken over several seasons, whilst at the remaining six the observations made were of a more general character.

The results showed that potash manures used at the rate of 2 to 4 cwts. per acre per annum are usually efficacious in controlling or greatly mitigating scorch within the course of two or three seasons where the soil conditions are of the Class I type and may also produce beneficial effects even in cases where the soil belongs to Class III. Drainage will also be usually required in cases in this latter category. No experiments were carried out on soils of the Class II category.

Grass Effect.

Observations were made at several centres on the effect of "grassing down" in ameliorating leaf scorch and in a few cases records were obtained relative to this point.

The general conclusions reached were that "grassing down" reduces leaf scorch in virtue of the treatment bringing about a lower nitrogen content of the plants and that, as a practical means of controlling scorch, the method used alone is not a good one, since the trees and bushes so treated usually become nitrogen starved and remain unprofitable. Used in conjunction with appropriate manuring with nitrogenous and potassic manures, however, "grassing down" may play a useful part in controlling scorch on certain areas.

Part V.

Conclusion.

The evidence accumulated in the investigations is regarded as supporting the view that leaf scorch results from defective nutrition. Much of it also points directly to the development of leaf scorch resulting from unsatisfactory conditions of water supply within the tissues of the plants.

In direct support of this view, we have the laboratory investigations of Summers (*loc. cit.*) on the production of leaf scorch by the rapid cutting off of water supply to the tissues of plants, of Barker and his colleagues (*loc. cit.*) on the drying out of root systems of trees, of Mann (*loc. cit.*) on the water content of potassium deficient leaves and the rate of transpiration of such leaves under conditions of relatively high summer temperatures, and of the writer in previous experiments (5) and in the experiments referred

to in the present paper on the control of leaf scorch by supplying adequate potash supplies either to the growth medium or as a spray to the foliage of potash deficient plants.

The soil conditions almost invariably associated with cases of leaf scorch in the field also suggest unsatisfactory conditions of water supply. The texture is either light and open or the soil is shallow and overlies an impervious subsoil, or drainage is poor and waterlogging occurs.

The two former conditions favour deficient water supply in dry periods and the third condition leads to root killing, and, as is well known, only specially adapted forms can thrive under such circumstances.

The evidence now available on the problem should prove of great value to the fruit grower. It is known that different classes of fruits, varieties and rootstocks differ in their susceptibilities to leaf scorch and the grower has in these a wide range of choice. It has been shown that certain soil conditions are conducive to the trouble and in many cases he will be able to avoid planting where such conditions occur. On certain of these soil areas, he may expect to grow fruit trees successfully by the initial choice of resistant plants and by subsequent appropriate manurial treatment, in particular by the regular use of potash manures and of dung, and by avoiding excessive applications of nitrogenous materials. On other areas, however, all his efforts are likely to prove of no avail and such should be rejected for purposes of fruit growing.

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EXPERIMENTS ON THE RELATION OF STRAWBERRY EELWORM (APHELENCHUS FRAGARIAE) TO "RED PLANT" AND "CAULIFLOWER" DISEASE OF STRAWBERRIES.

PROGRESS REPORT.

BY L. N. STANILAND AND T. SWARBRICK.

INTRODUCTION.

In the early stages of the investigation of strawberry diseases at Long Ashton, Ballard and Peren (1) concluded that "Cauliflower" disease was due to the attack of *A. fragariae*. They examined "Red Plants" in the region of the growing point and found *A. fragariae* present in large numbers. They were able to correlate the symptoms of "Cauliflower" and "Red Plant," and this correlation, considered in conjunction with the presence of *A. fragariae* in "Red Plants," led them to the conclusion that the "Cauliflower" and "Red Plant" diseases were caused by *A. fragariae* and that these two types of abnormal plants were probably due to varying responses of the plants to eelworm attack.

Ballard and Peren also examined the type of plant now known as "Small Leaf," and found that *Aphelenchus* was also present in these plants. They concluded therefore that "Small Leaf" was also due to the same cause, namely attacks of the eelworm *A. fragariae*. The distribution of *A. fragariae* in "Small Leaf" plants was not discussed in detail and no mention was made of the possible occurrence of *A. fragariae* in healthy plants.

"Red Plant," "Cauliflower" and "Small Leaf" were thus attributed to the attacks of *A. fragariae*.

Lees and Staniland (2) found *Aphelenchus* evenly distributed in small numbers in the leaf axils of normal plants. This distribution was general in normal plants from a number of districts (examinations were carried out during the period June to September). In October and November examinations of similar plants, they found *Aphelenchus* in the growing points of a few healthy plants. It was suggested by these workers that the presence of *A. fragariae* alone was not enough to account for "Red Plant."

Staniland (3) found that the majority of a number of healthy plants collected for the purpose of an infection experiment had *A. fragariae* present in the outer leaf bases and, in a few instances, in the region of the growing point. It appears therefore that *A. fragariae* is a frequent inhabitant of the normal strawberry plant, although the growing point region is usually free from eelworm.

Though it was found impossible to free the plants in question from eelworms, a small infection experiment was carried out, large numbers of eelworms being introduced into the leaf axils of runner plants. None of the plants so treated developed the disease. Infections of similar plants with eelworms directly into the growing point region also yielded similar negative results.

Ball (4) listed the symptoms of the " Red Plant " and discussed the effect of roguing on the percentage of " Red Plant " present in various strains of plants. It had previously been thought that there was no recovery from " Red Plant," but in this work Ball reported the first case of apparent recovery from this condition.

Infection Experiments, Season 1927-28.

Although it has not been found possible to procure healthy plants unquestionably free from *A. fragariae*, further infection experiments have been carried out during the Season 1927-28. The method of infection has been described in a previous paper (3).

Large numbers of *Aphelenchus* in suspension in water (together with the other genera of eelworms common to the strawberry plant) were introduced into apparently healthy plants of the variery " Royal Sovereign." The following infection experiments were carried out :—

(1) Eelworms were introduced into 24 plants, as near the growing points as possible.

Untreated plants were kept for control purposes.

(2) Eelworms were introduced into the outer leaf axils of 24 plants.

Untreated plants were kept for control purposes.

(3) Runners from five plants were pegged into pots of sand, the crowns being kept as low as possible. The sand round the crowns was saturated with a suspension of eelworms at intervals, six times in all for each crown.

A control runner on each plant was saturated with water only. The dates on which the runners received eel-

worms in suspension (or water only) were May 31st, June 1st, June 4th, June 9th, June 20th and June 26th.

(4) A suspension of eelworms was introduced into the outer leaf axils of six plants on six occasions (at the same times as in Experiment 3), before the runners began to appear. Control plants in which water was similarly added were kept.

The above infection experiments were carried out in May and June, 1927. Examination of the infected plants and the runners produced by them was made the following year (May 1928). The results of those examinations are shown below :—

(i) None of the plants developed " Red Plant " symptoms.

(ii) None of the plants developed " Red Plant " symptoms.

(iii) The results are shown in Table I :—

TABLE I.

Plant.	Condition in May, 1928.	
	Infected Runner.	Control Runner.
1.	" Red Plant."	" Red Plant."
2.	" Red Plant."	" Red Plant."
3.	Two runners, both healthy.	" Red Plant."
4.	Two runners. One healthy ; the other " Red Plant."	Healthy.
5.	Healthy.	Healthy.

It should be noted from these results that, although the parent plants remained healthy, there was a definite tendency for the runners from any one plant all to turn into " Red Plants " or all to remain healthy. The runners were all examined for *A. fragariae* in May 1928, *i.e.* a year later than the inoculation treatment. Those runners which developed " Red Plant " symptoms contained at this time large numbers of *A. fragariae*, while those which remained healthy in appearance had only the usual small numbers of eelworm present, distributed mostly in the outer leaf bases, despite the fact that some of them had been heavily infected with eelworm.

None of the parent plants had more than the small number of eelworms usually present in healthy plants.

(iv) None of the runners from these plants developed "Red Plant" symptoms.

Distribution of Aphelenchus in Runners from "Red Plant" Crowns.

Since runners from "Red Plant" crowns are considered to have a definite tendency to develop "Red Plant" symptoms in the following year, it was thought that such runners would, in all probability, be infected with *Aphelenchus* at an early stage of their development. Seventy-three first runners from definite "Red Plant" crowns were therefore examined for *Aphelenchus* during the period June 9th-July 6th, 1927. At this time the runners were still attached to the parent plants by the stolons and some of the runners were still in the very early stages of development. In every case, except three specially selected ones, these runners showed no external "Red Plant" symptoms.

Each runner and its stolon was gently washed with water and each stipule was examined separately. The growing point region was macerated with needles and also examined.

The results of these examinations were as follows:—

Aphelenchus present on outside of stolon	3 runners.
Aphelenchus present in small numbers in growing point region	1 runner.
Aphelenchus present in large numbers in growing point region, together with eggs	1 runner.
Runners with slight "Red Plant" symptoms but with no *Aphelenchus* present	3 runners.
Apparently healthy runners with no *Aphelenchus* present	65 runners.

To obtain further information on the distribution of *Aphelenchus* in runners from "Red Plant" crowns, one, and in some cases two, runners from a number of definite "Red Plant" crowns were pegged down into pots. At the same time, a second or third runner, in the same stage of development and produced by the same crown, was examined for *Aphelenchus*. Six plants were included in this experiment. The potted runners were examined the following May and June (1928) for "Red Plant" symptoms. Table II sets out the condition of the potted runners in June 1927 and in the May-June period 1928, together with the eelworm content of the comparative runners in the period June 1927.

Of the six comparative runners examined in June 1927, only one had any appreciable *Aphelenchus* content, yet of the ten

potted runners four developed "Red Plant" symptoms in the following year.

This method of examining plants for eelworm and at the same time potting up comparative runners for future observation was devised because of the obvious impossibility of examining a plant for eelworm and continuing observations upon it.

Observations upon the Apparent Recovery from "Red Plant."

In connection with some experiments upon the correlation of physiological conditions, eelworm content and "Red Plant" of strawberries, discussed in a later section, a large batch of runners was planted out in autumn 1927.

In mid September 1927, about 120 runners which were apparently healthy but arising from very pronounced "Red Plant" crowns, were taken up out of the field and transplanted. A number of these were examined for eelworm content. Those which remained were kept under observation and on May 17th, 1928, were grouped as follows :—

11	were	Red plant or Cauliflower	14%
55	,,	Healthy with flower	69%
14	,,	Healthy but blind	17%

The "Red Plants" were blind, and thus, of the total number of plants, 31% were blind, of which 14% were red and 17% healthy, *i.e.* of the blind plants approximately 44% were red plants.

The healthy blind plants may probably be accounted for owing to the late date at which the runners were taken, flower differentiation taking place during August.

TABLE II.

Plant No.	Potted runner June 1927.	Eelworm content of a comparative Runner examined June 1927.	Potted runner June 1928.
1. 1yr. old. "Red Plant."	1(a) Did not appear normal at time of potting	Nil.	1(a) Red Plant.
	1(b) Appeared healthy.		Healthy.
2. 1yr. old. "Red Plant."	2(a) Appeared Red at potting. Heavy red colouration.	Nil.	Healthy.
	2(b) Appeared healthy.		Healthy.
3. 2yr. old Plant with 3 crowns 2 of which were Red. Runners taken from the worst red crown.	3(a)	1 Aphelenchus (apparently dead in leaf bases. Growing point nil.	"Red Plant."
	3(b)		"Red Plant."
4. 2yr. old plant. 2 crowns both Red.	4(a)	1st leaf base 9 Aphelenchus. Growing point—large No.	"Red Plant."
5. 2yr. plant. 3 crowns 2 Red and 1 healthy	5(a) Appeared Red.	Nil.	"Red Plant."
	5(b) Appeared a little healthier.		Healthy.
6. 2 yr. plant. 1 Red crown. 1 crown going Red. 1 healthy. Runners from worst.	6(a)	Nil.	Healthy.

By July 8th, 1928, only one of the eleven plants showing "Red Plant" symptoms on May 17th was still affected. The remaining ten had apparently recovered.

The above observations are contrary to previous experience and, in the present stage of our knowledge, we have no explanation to offer. In view of the care taken in selecting the above-mentioned runners only from crowns severely affected with "Red Plant," these observations may have particular significance.

The Relation of Seasonal Aphelenchus Content to "Red Plant" and its Correlation with Physiological Conditions of the Plant.

It was decided to make anatomical examinations of a number of Strawberry plants at suitable intervals and at the same time to examine these plants for *Aphelenchus*, noting if there were any marked priority in the occurrence of an increased *Aphelenchus* content or of the "Red Plant" symptoms.

For this work a number of apparently healthy runners arising from definite "Red Plant" crowns were taken up out of the field and re-planted. A sufficient number was taken to allow of the collection of batches of ten for examination at convenient times.

It was planned to lift and examine these apparently healthy runners at intervals until spring. It was thought, from past experience, that many of these plants would subsequently show "Red Plant" symptoms.

The plants lifted were examined for

(*a*) *Aphelenchus* content and distribution.
(*b*) Starch content.
(*c*) Occurrence and character of endodermis.
(*d*) Thickness of cuticle.

It was hoped that, by this method, it would be possible to detect any marked change in the normal physiological condition of the plants or *Aphelenchus* content which could be regarded as definitely prior to the appearance of characteristic external "Red Plant" symptoms. Healthy runners from healthy parent plants were examined concurrently with the runners from the "Red Plant" crowns.

Before actually commencing this study, a preliminary survey of plants in the field was carried out. It was found that, in general,

Aphelenchus was only present in quantity when definite "Red Plant" symptoms were in evidence. Among multi-crown plants all possible combinations between "Red Plant," "Cauliflower" and healthy plants were found and examined. As a general rule, a healthy crown never had more than a few eelworms present even though all the remaining crowns on the same plant were definite "Red Plant" or "Cauliflower" crowns in an advanced stage, and these invariably contained large numbers of *Aphelenchus*.

Assuming that *A. fragariae* is the causal organism producing "Red Plant" and "Cauliflower," it would be expected that some healthy plants would be found which would have greater numbers of *A. fragariae* present in their growing point regions than those usually associated with normal plants. Out of large numbers of healthy plants examined over a period of several years no healthy looking plant has ever been found to contain more than a few individuals of *A. fragariae*, and these usually occur in the outer leaf bases.

In this periodical examination of runners from healthy and "Red Plant" crowns, the notes on *Aphelenchus* were confined to the growing point region only, it having been demonstrated that, in the majority of plants, healthy or otherwise, a few individuals may usually be found in the outer leaf axils.

The results of the examinations are here given. The runners from "Red Plant" crowns are referred to as "apparently healthy" because at the time of taking they showed no external "Red Plant" symptoms, and those from healthy parents as "healthy." It should be noted, however, that during the period of investigation some of these "apparently healthy" runners turned into "Red Plants." They are still classified, however, under the original title.

Nov. 10th, 1927.

"Apparently healthy" runners.

1. No *Aphelenchus*.
2. 2 „
3. No „
4. No „
5. No „

Nov. 11th, 1927.

Healthy runners.

1. No *Aphelenchus*.
2. 2 „
3. No „

Feb. 13th, 1928.

"Apparently healthy" runners.

1. No *Aphelenchus*.
2. No „
3. No „

Feb. 14*th*, 1928.

Healthy runners.

1. No *Aphelenchus.*
2. No ,,
3. No ,,
4. No ,,
5. No ,,
6. No ,,
7. 2 ,,

April 5*th*, 1928.

" Apparently healthy " runners.

1. One leaf showing slight " Red Plant " symptoms, *Aphelenchus* more abundant than usual in leaf axils.
   Growing point region—30 *Aphelenchus.*
2. Still appeared healthy. No *Aphelenchus* present in growing point region.
3. Advanced "Red Plant." *Aphelenchus* more abundant than usual in the leaf axils.
   Growing point region—over 100 *Aphelenchus.*

" Healthy runners from Healthy parents."
None of these plants had *Aphelenchus* present in the growing point region.

April 18*th*, 1928.

" Apparently healthy " runners.

1. " Red Plant."
   Aphelenchus very numerous in leaf axils (from 1-600 in each axil).
   Growing point region—over 100 *Aphelenchus.*
2. Slight " Red Plant " symptoms.
   Aphelenchus more numerous than usual in outer leaf axils. Growing point region—over 100 *Aphelenchus.*
3. Still appeared healthy.
   No *Aphelenchus* present in growing point region.

" Healthy runners from Healthy parents."
None of these plants had *Aphelenchus* present in the growing point region.

The Occurrence of " Red Plant " Symptoms and Eelworm Content in Relation to Growth Cycle.

A preliminary survey of runners from both healthy and " Red Plant " crowns carried out on August 23rd, 1927, showed that

(*a*) The endodermis was not consistent enough as a basis for diagnosis but tended to be more complete and more heavily impregnated with fatty substances in runners arising from " Red Plants " but which were still apparently healthy, *i.e.* showed no external signs of " Red Plant."

(*b*) The cuticle was thinner on stolons than on petioles in the case of healthy plants. In " Red Plants " the cuticle on the stolon was comparatively thick, but cuticle on petioles of " Red Plants " was thinner than usual. There was a definite tendency for the cuticle of the leaf

petioles of runners from " Red Plants " to stain brown, rather than red, with Sudan III. This was correlated with the tendency for these cuticles to run into globules. At that time (August 1927) it was possible to pick out with a fair degree of certainty from mixed batches of runners those which had arisen from " Red Plant " crowns, simply on the anatomical characteristics mentioned above.

(*c*) There was a marked tendency for " Red Plant " crowns and the whole of the system of runners arising from those crowns to have a high starch content, whether such runners were themselves showing " Red Plant " symptoms or not.

" *Apparently Healthy* " *Runners taken from* " *Red Plant* " *Crowns and Planted out Middle of September* 1927, *were* :—

(*a*) Examined November 10th and 11th, 1927.

It was found that, as compared with healthy runners from healthy plants, those taken from " Red Plants " showed a high starch content even when they showed no external " Red Plant " symptoms. This difference was most in evidence in the medulla region of the crown and was almost undetectable in the petioles.

The cuticles of both sets of plants were comparatively thin and the endodermis varied considerably, so that neither of these two features could be used for diagnosis. The nature of the cuticular deposit as shown by Sudan III stain differed in the plants arising from " Red Plant " crowns from that of plants from healthy plants.

(*b*) Examined February 13th and 14th, 1928.

The differences in starch content found during the previous autumn had by this time almost disappeared. The cuticles of all runners were appreciably thicker than they were in November and stained more intensely with Sudan III.

The endodermis was fairly complete in all cases.

(*c*) Examined April 18th, 1928.

On this date differences between plants showing the beginnings of definite " Red Plant " symptoms and those remaining healthy were most marked. The plants remaining healthy were putting out new healthy leaves and had but little starch remaining in the crown. The remaining starch grains were swollen and obviously undergoing rapid hydrolysis. Contrasted with this, the " Red Plant " runners still retained their high starch content, the starch grains showing little signs of hydrolysis.

The cuticles and endodermis of the winter leaves showed but little differences between the " Red " and healthy plants.

The marked difference in starch hydrolysis outlined above must be regarded as indicating marked physiological differences in internal condition between normal and " Red Plants."

Anatomical observations made in November 1926 and February and April 1927 have indicated that, in the present state of our knowledge, cuticle thickness and endodermis are not reliable as diagnostic characters. In August, however, when used carefully, they had considerable value. The fact that high starch content usually accompanies " Red Plant " symptoms in any system of a crown and its runners, and is exhibited most markedly in spring, is indicative of different physiological states during winter. Our technique, however, served only to reveal the major aspects of these differences.

The work was therefore discontinued as it was realised that, as " Red Plant " leaves were being unfolded at flowering time, they probably had been initiated some time during the previous summer or autumn. This puts the formative period of these " Red Plants " at some time during the previous season.

It is stressed that *Aphelenchus* was present in only a small percentage of the growing points of the above runners from " Red Plant " crowns when examined in June, July, August, November or February, and, where present in such growing points, the number only exceeded two eelworms in one case.

The experiments recorded in this paper have undoubtedly advanced our knowledge of the relations between eelworms and " Red Plant " of strawberries. This relation, is, however, not yet critically established. The major difficulty of a critical piece of work is that of obtaining eelworm-free plants. The only other course open is to work with a sufficient number of plants so that any results obtained shall have significance when regarded from the statistical point of view. The experiment upon the inoculation of plants growing in sand recorded in this paper offers suggestive lines of attack upon the causal relation of eelworms to " Red Plant." It is planned to carry out further experiments along these lines.

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THE LONG ASHTON TAR DISTILLATE WASH: FIELD EXPERIMENTS, 1927-28.*

By L. N. Staniland and C. L. Walton.

Previous field trials with tar-distillate washes by the Long Ashton Research Station had dealt solely with commercial brands of these washes, and it had been realised for some time that standardisation of tar-distillate washes was much to be desired from all points of view.

Mr. L. E. Smith (9) carried out investigations at the Station in connection with tar-distillate spray fluids, with the aid of a grant from the Ministry of Agriculture and Fisheries. The purpose of the work was to investigate the various factors concerned with the preparation of clear, concentrated tar-oil fluids and of stable, dilute tar-oil emulsions; and to determine to what extent the toxic properties of the fluids could be correlated with various constituents. The latter part of the work was not completed, but considerable advance was made with chemical work in connection with the behaviour of preparations of the total tar-distillate.

Mr. F. Tutin, Biochemist at the Station, in the course of a study of these washes during 1927, was able to produce a standard wash which, as a result of laboratory tests, gave promise of being superior to any of the commercial brands of tar-distillate washes so far tested. The object of the trials described in this paper was to verify the conclusions arrived at in this manner. This spray was tested against a commercial brand of wash which had, in all previous experiments, given consistently good results.

Mr. F. Tutin's work (15), referred to above, consisted primarily in the emulsification of the various products present in tar-distillates. Each separate emulsified product was tested on Winter Moth eggs on a considerable scale. The results of these tests showed conclusively that the neutral material boiling from 280° to 360° C. was more effective than a mixture of this product with the "tar acids." The next problem was to find means of

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emulsifying the " high neutral " product, suitable for use on commercial scale, in the absence of " tar acids." This was finally accomplished by means of two products, viz. two sulphonated oils known as Agral W.B. and Agral A.X. respectively.

The emulsification is effected by dissolving in every 10 parts of the " high neutral " tar-distillate one part of Agral W.B. or A.X. This gives a concentrate which may be finally emulsified by the addition of the required quantity of water and one part of 20 per cent. aqueous caustic soda.

Field Trials with the Long Ashton Spray.

Trials were carried out at three centres in the county of Gloucester and two washes were tested—the Long Ashton tar-distillate spray and a well-known proprietary brand as a Standard. A special object was to obtain information concerning the effectiveness of these washes for the control of Capsid eggs.

It may not be out of place in this connection to point out that favourable results have been obtained against Capsid in certain previous trials in the Bristol Province (5, 10, 11). In one instance (10), a commercial control was obtained by the use of a proprietary brand at 10 per cent. strength applied in early March to trees of the variety Newton Wonder. This trial was carried out on the same trees utilised this year at Centre III.

In the 1924-25 trial, referred to above (10), the fruit from the control trees was so badly marked by Capsid Bug as to be difficult to dispose of, whereas fruit from the sprayed trees, after thinning, obtained a first prize in the barrel section at the Imperial Fruit Show. That such results are by no means usual may be gathered from a perusal of the literature on the subject and correspondence in fruit journals, and it was for this reason that further work was undertaken at Long Ashton.

Marking.

The system of marking employed was the same as that used in 1925 and 1926. The method, which did not attempt to differentiate more finely than an estimated 10 per cent., was as follows. All the trees in a treatment were inspected as a whole, and each treatment was marked with a number from 0 to 5 according to the following scale :—

0 ..... = no pest present.
1 ..... = pest very slight.
2 ..... = „ slight.
3 ..... = „ moderate.
4 ..... = „ bad.
5 ..... = „ very bad.

In cases of indecision, an intermediate figure was given. All the figures were then doubled; "very bad" thus received 10, whilst lesser intensities of attack were allotted corresponding smaller numbers.

Centre I. Cheltenham. Variety of Apple—Newton Wonder (12 year old trees).

Treatments:

(*a*) *Single Sprayings.*

10	per cent.	Long Ashton spray	..	23	trees
6	,,	,,	,,	,,	..	10	,,
10	,,	,,	Standard Wash	..	10	,,
6	,,	,,	,,	,,	..	10	,,

Date of Application—February 8th, 1928.

Weather—Sunny and dry. Practically no rain at night or following day.

(*b*) *Double Sprayings.*

5 per cent. Standard wash followed by 5 per cent. Standard wash.

5 per cent. Standard wash followed by 10 per cent. Standard wash.

10 per cent. Standard wash followed by 5 per cent. Standard wash.

10 trees in each treatment.

Dates of Application—First spraying February 8th, 1928. Second spraying February 22nd, 1928.

Weather—Sunny and dry. No rain fell for some days.

(*c*) *Controls.*

Six trees in each control, four times repeated.

Emulsification of sprays. The Standard wash emulsified well. In the case of the Long Ashton spray a considerable amount of the anthracene oils was thrown out. Analysis revealed the fact that this was due to unforeseen quantities of sulphates present in the water used to mix the sprays. This may easily be remedied by increasing the percentage of emulsifier in the spray concentrate. It will be seen that in spite of the poor emulsification above mentioned, results of a high order were obtained.

The layout of the trial is given in Diagram I, where the arrangement of the blocks of trees is given and the treatment is indicated. The results are indicated in the diagram by means of different types of shading and also by figures, according to the key attached to the diagram. The layout and results are similarly given for Centre II in Diagram II. The pests present in this trial were Caterpillars and Capsid Bug. Diagram I shows that the intensity of attack of Capsid Bug was rather lower at that end of the trial plot remote from the farm buildings. The results shown in this diagram were obtained on April 23rd, 1928. A second examination was made on May 7th, 1928, and, though the damage by the pests was naturally more apparent, the results then obtained were closely in agreement with those given in Diagram I.

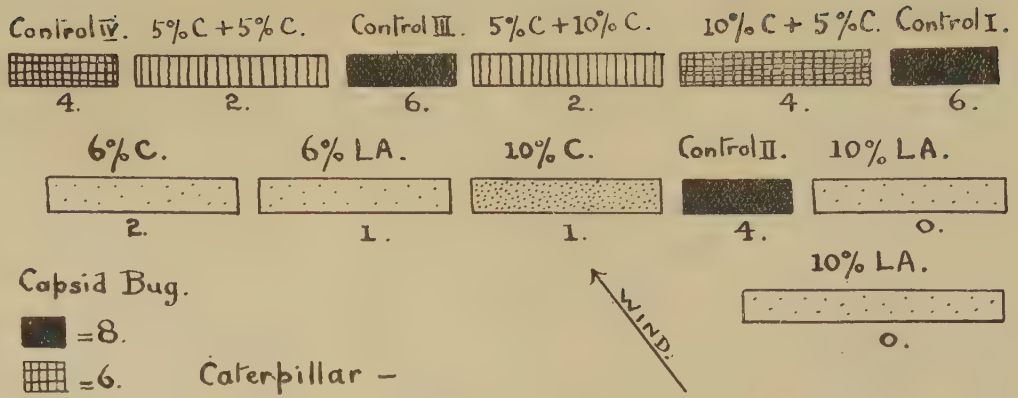
A third examination was made on June 18th, 1928, for fruit markings due to Capsid Bug. On account of frost damage, the crop was poor and very irregular. All the fruit therefore was counted and the percentage of marked fruit determined. All fruits bearing any definite Capsid markings were counted as marked fruit. This is pointed out to make clear that all the marked fruit was not necessarily so badly marked as to become unsaleable. These figures are given in Table I.

Table I.

Treatment.	No. of Fruits counted.	No. of Apples marked by Capsid Bug.	Percentage of marked Apples.
Control I	45	38	84
10 per cent. Long Ashton spray ..	179	35	19
Control II	9	9	100
10 per cent. Standard wash ..	34	17	50
Control III	No fruit present	—	—
6 per cent. Long Ashton spray ..	13	1	7
6 per cent. Standard wash ..	38	13	33
Control IV	6	2	33

Centre II. Cheltenham. Variety of Apple—Newton Wonder (15 year old trees).

DIAGRAM 1.



Capsid Bug.

=8.

=6.

=4.

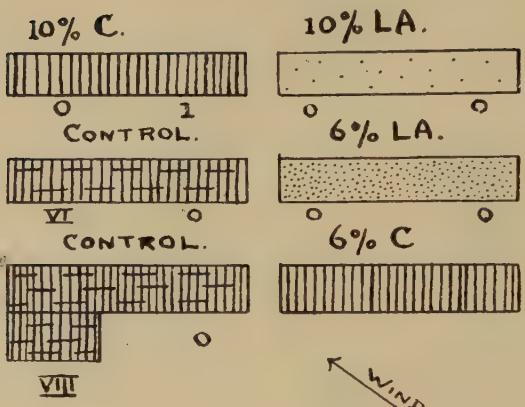
=2.

=1.

Caterpillar – Figures below.

Treatments – written above.

DIAGRAM II.



Treatments:

(*a*) *Single Sprayings.*

10	per cent.	Long Ashton spray	..	5 trees
6	„ „	„ „ „	..	5 „
10	„ „	Standard Wash	..	5 „
6	„ „	„ „	..	5 „

Date of Application—February 7th, 1928.

Weather—Slight and very intermittent drizzle. Heavy rain during the following night.

(*b*) *Controls.*

13 trees arranged in a roughly triangular block at one corner of the trial. This arrangement was made owing to the presence of an intermittent breeze in order to keep the controls free from spray drift.

Emulsification of Sprays. Both the Standard wash and the Long Ashton spray emulsified perfectly.

The layout of the trial and the first results obtained are given in Diagram II. The examination was made on April 23rd, 1928. The pests present in this trial were Apple Sucker, Caterpillars, and Capsid Bug. A second examination was made on May 7th, 1928, and fully confirmed the first results obtained. A third examination was made on June 18th, 1928, for fruit markings due to Capsid Bug. The crop, owing to more sheltered conditions, was much less affected by frost than at Centre I. Accordingly, all the fruit was not counted, but random samples were taken, except in the case of some trees where the crop was light and all the fruit was examined. The figures obtained at this Centre are given in Table II.

TABLE II.

Treatment.	No. of Fruits counted.	No. of Apples marked by Capsid Bug.	Percentage of marked apples
Control	350	281	80
10 per cent. Long Ashton spray ..	137	21	15
6 „ „ „ „ „ ..	100	40	40
10 „ „ Standard wash ..	244	144	60
6 „ „ „ „ ...	64	48	75

Centre III. Arle, near Cheltenham. Variety of Apple—Newton Wonder (14 year old trees).

Treatments:

(*a*) *Single Sprayings.*

10 per cent. Long Ashton spray—6 trees twice repeated.

10 per cent. Standard wash—6 trees twice repeated.

Date of Application—February 7th, 1928.

(*b*) *Controls.*

5 trees twice repeated.

Emulsification of Sprays. Both the Standard wash and the Long Ashton spray emulsified perfectly.

The pests present were Caterpillar and Capsid Bug. The first examination was made on April 23rd, 1928, and the results obtained are shown in Table III. The averages for each treatment are given since each treatment was carried out twice.

TABLE III.

Treatment.	Caterpillar.	Capsid Bug.
Control	1	7
10 per cent. Long Ashton spray	0	2
10 per cent. Standard wash..	0	2

A second examination made on May 7th, 1928, confirmed the above results. Further figures on fruit markings could not be obtained since, owing to frost injury, there was no crop.

Discussion.

Single Sprayings. The figures under this heading seem to us so clear as not to need further discussion, except in so far as the infestation in Centre I (Diagram I) in the region of Control No. IV was distinctly less than at the other end. This being so, too much importance should not be attached to results obtained on the immediately adjacent plots. Nevertheless, correspondence is observable between these and similar results at Centre II (Diagram II).

Double Sprayings: *Centre I.*—The outstanding point is that in no case have any of the double sprayings given such good results as single applications of 10 per cent. washes; this applies both to the commercial wash and the Long Ashton wash.

It should be noted that two of the double sprayings included a 10 per cent. application in each case, and that the results from these were more comparable with the two applications of 5 per cent. than with the single applications of 10 per cent. We have no explanation to offer for this somewhat anomalous result.

Summary and Conclusions.

(1) In field trials with

(*a*) a tar-distillate wash made up at Long Ashton, and referred to as the Long Ashton spray, and (*b*) a Standard wash used at the same strengths, the insect eggs present were Apple Sucker (*Psylla*), Winter Moth and Capsid Bug (*Plesiocoris*).

(2) The strengths used in the case of both washes were 10 per cent. and 6 per cent.

(3) *Psylla* was completely controlled by both strengths of the sprays tested.

In the case of Caterpillar, commercial control was obtained in the case of both washes used at 10 per cent. strength, this being particularly marked in the case of the Long Ashton wash. At the 6 per cent. strength, there was a slight superiority on the part of the Long Ashton spray.

The 10 per cent. strength Standard wash brought about considerable reduction of Capsid Bug but did not give a commercial control such as was obtained by the use of the Long Ashton spray at the same strength.

At the 6 per cent. strength, the Long Ashton spray was still found to be superior to the Standard wash, but in this case neither spray could be said to have given a satisfactory control.

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THE PREPARATION OF A PYRETHRUM SPRAY FLUID.

By F. Tutin.

The insecticidal properties of the flowers of certain species of *Pyrethrum* have long been known*, but as yet no satisfactory preparation of the active principles of these flowers adapted for employment in the field as a spray appears to have been devised.

It came to the knowledge of the present author about 15 years ago that the specific toxic substances present in *Pyrethrum* are insoluble in water, but can all be removed from the powdered flowers by means of extraction with light petroleum. It has therefore been sought to bring such an extract into a form in which it could be readily emulsified, and applied as a spray. In view, however, of the comparatively small yield of active product obtainable from the flowers and of its remarkably high toxicity it was deemed desirable to employ some suitable product as a diluent, which would act as a " carrier " of the toxic agent in the spray fluid. It was considered that this purpose might be usefully fulfilled by a fatty oil, since such a product would be relatively harmless to plants and would certainly be capable of dissolving the active principle, since the latter is soluble in light petroleum. Moreover, it has been shown by Staniland† that certain fatty oils, notably Rape oil, have a distinct value in themselves as contact insecticides, and it therefore appeared probable that the incorporation of an oil, such as Rape oil, with the active principles of the *Pyrethrum* flowers might yield a product possibly even more deadly to insect life than *Pyrethrum* extract alone in equivalent amount.

The present author has shown‡ that very satisfactory emulsions of Rape oil may be prepared by means of Agral W.B. or Agral I, and it has now been ascertained that the same means may be employed with equal facility for the emulsification of a Rape oil solution of the active principles of *Pyrethrum* flowers.

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* Compare Fryer, Tattersfield and Gimingham, *Annals of Applied Biology*, 1928, XV, 423, and Martin, *The Scientific Principles of Plant Protection*, 1928, p. 127, where references to the published work on the subject will be found.

† Annual Report of the Long Ashton Research Station, 1926, p. 78.

‡ *Ibid*, 1927, pp. 89 and 90.

The pyrethrins, as the toxic substances in *Pyrethrum* flowers have been called, have been shown to be esters, and as such, are readily hydrolysed by means of alkalis. Moreover, it is known that hydrolysis of the pyrethrins results in the destruction of their insecticidal powers. It is evident, therefore, that any spray liquid depending for its insecticidal value on the presence of an active *Pyrethrum* preparation must be prepared in such a way as to preclude the hydrolysis of the pyrethrins occurring on keeping. This consideration at once rules out the possibility of making any satisfactory preparation containing a soap or any other alkaline agent as an emulsifier. In fact, it is highly probable that any hydrous emulsion containing pyrethrins would, on keeping, suffer loss of activity due to slow hydrolysis occurring even in the absence of free alkali.

A solution of the crude pyrethrins in Rape oil, to which Agral W.B. has been added, is free from these objections, since it contains neither water nor alkali and it has, in fact, been found that such a solution suffers no detectable decrease of activity on keeping for a number of months.

In order to prepare an emulsion suitable for application as a spray from a Rape oil solution of the pyrethrins and Agral W.B., the requisite amount of this mixture is added to the water when required for use and a very small amount of alkali then introduced. On shaking, an excellent emulsion is formed which possesses very high insecticidal powers and which does not deteriorate too rapidly to be capable of satisfactory, practical use. Even, however, when the amount of alkali in such an emulsion is so small as to be barely capable of detection, hydrolysis, doubtless of a catalytic nature, does take place, and after keeping for rather more than three weeks such an emulsion becomes comparatively inactive and then possesses no greater insecticidal power than is shown by an emulsion of Rape oil only of corresponding strength. It is important, therefore, that emulsions of *Pyrethrum* preparations should only be made up immediately before they are required for use.

For the purpose of preparing a *Pyrethrum*-Rape oil spray liquid, a commercial sample of Dalmatian flowers was employed in the first place. A quantity (1310 grams) of the coarsely ground, air dried flowers was extracted by continuous percolation in a large-Soxhlet apparatus with light petroleum (b.p. 30-40°). The resulting extract, on evaporation, yielded a yellowish, sticky residue amounting to 18.73 grams or 1.43 per cent. of the weight of the dried flowers employed, and containing the crude pyrethrins. A portion of this material (2.86 grams) was dissolved in 180 cc. of Rape oil and the resulting solution mixed with 20 cc. of Agral W.B. In

order to emulsify this mixture for use as a spray, 1 cc. of it was added to 100 cc. of water, 0.1 cc. of aqueous 20 per cent. sodium hydroxide introduced, and the mixture shaken. A very good emulsion, which frothed well, was immediately formed. This emulsion would contain approximately 0.9 per cent. of Rape oil together with an amount of the pyrethrins corresponding to the presence of 1 per cent. of the original *Pyrethrum* flowers in the emulsion.

Effect of Pyrthreum Spray on Insects.

The efficacy of this spray was then tested against a number of insects, when death resulted in all cases. The results of some of the experiments are given below :—

I. *Early Thorn Moth.*

Twenty larvae, most of them nearly full grown, whilst feeding on apple were sprayed with the *Pyrethrum* mixture. In a few hours 19 were dead and 1 moribund. As controls 20 larvae were sprayed with 0.9 per cent. Rape oil emulsion, whilst 20 more were untreated. One very small larva was killed by the Rape oil, but all the rest remained healthy.

II. *Willow Saw-fly Larvae.*

Experiments as described under I. were repeated, using larvae of the Willow Saw-fly, when precisely similar results were obtained.

Another lot of saw-fly larvae were sprayed with emulsion which had been kept for 24 days after mixing. The next morning all were feeding normally. They were then sprayed with some freshly-prepared emulsion, after which all were dead in a few hours.

III. *Willow Beetles.*

Several hundreds of the Willow Beetle, *Phyllodecta vulgatissima*, were liberated on a bunch of willow twigs inserted in the centre of a tray of soil. The twigs and beetles, together with the surrounding soil, were then sprayed with the *Pyrethrum* mixture. All the beetles were very soon killed, none escaping despite the fact that they were not confined. The larvae of *P. vulgatissima* were also very easily killed by the spray, as were also beetles of the related species *P. vitallinae.*

The eggs of *P. vulgatissima* did not appear to be destroyed by treatment with the *Pyrethrum* spray, but in all cases where the eggs hatched within about a week after the application of the spray, the young larvae died immediately after leaving the egg. In cases where a more considerable interval elapsed between the time of

application of the spray and the hatching of the eggs, a few of the larvae survived. It would appear from this that at least two sprayings, with an interval of about a week, would be necessary to free willows from this pest.

Two hundred *P. vulgatissima* beetles were heavily dusted with sodium fluosilicate, but none were killed, all remaining active and apparently uninjured.

IV. *Raspberry Beetle, Byturus tomentosus.*

About 100 Raspberry Beetles were liberated on raspberry foliage stuck into the centre of an earth-filled tub. The beetles, foliage and surrounding earth were then sprayed with the *Pyrethrum* mixture. In a short time the beetles were seriously affected. Only two managed to reach the edge of the tub, a distance of 8 inches, whilst none escaped. In the case of this beetle, however, death did not ensue, in the majority of cases, so rapidly as it did with the Willow Beetles, although all were paralysed and unable to walk. Even after two days about 50 per cent. of the beetles were capable of making slight movements of the legs, but none appeared to recover.

V. *Carabid Beetles.*

Since it had been noted that considerable damage to the strawberry crop was being caused by *Carabid* beetles, the effect of the *Pyrethrum* spray on these insects was investigated. In each case unsprayed beetles kept as a control remained active.

Thirteen specimens of *Osmaceus vulgaris* were placed in a large, open dish and sprayed with the *Pyrethrum* mixture. In two days all were dead, as were also two unsprayed beetles which were introduced into the sprayed dish after the spray had dried. A Tiger Beetle placed in the same dish two days after the application of the spray also died in due course. It is evident, therefore, that the active material in the spray remains effective for some days and, moreover, that it is not essential for the insects themselves to be drenched with the spray, since they were killed when kept on a surface which had been previously sprayed and then allowed to dry. In confirmation of this it was found that six *O. vulgaris* beetles all died when kept on soil which had previously been lightly sprayed with the *Pyrethrum* mixture. Similar experiments conducted with *Harpalus ruficornis* and other smaller *Carabid* beetles resulted invariably in the death of the insects.

VI. *Other Insects.*

The weevil *Otiorrhynchus clavipes* proved more resistant to the effect of the *Pyrethrum* spray than any other insect with which

trials were made. Eleven specimens of the weevil were sprayed in an open tin, but even after four days two of them were still alive.

Several species of *Aphis* were treated with the *Pyrethrum* spray, both under glass and in the open air, and in all cases a complete "kill" seemed to be effected. Earwigs were also quickly killed by the spray.

VII. *Red Spider.*

An apple tree grown in a pot in a greenhouse had become heavily infested with the red spider *Oligonychus ulmi*. One branch of it was sprayed with the *Pyrethrum* mixture, the remainder of the tree being left unsprayed. One hour after spraying no living red spider could be found on the treated branch. Moreover, no reinfection of the sprayed portion took place until 3 weeks later .

It was also observed that wood-lice were very quickly killed by the *Pyrethrum* spray.

Effect on Vegetation.

In no case where the above-described *Pyrethrum*-Rape oil spray mixture was used on living plants was any damage to vegetation observed; even very young leaves, and flowers, appeared to be quite unaffected. The young, tender fronds of ferns growing in a greenhouse were also in no way damaged by the spray.

Use of the Pyrethrum Spray in the Field.

Since the above-described trials against insects yielded such satisfactory results it was deemed desirable to conduct some larger-scale experiments in the field. For this purpose, however, it was considered advisable to modify the composition of the spray mixture slightly so as to ensure that a good emulsion should be obtainable, even when circumstances compelled the use of a really "hard" water. To attain this end it was necessary appreciably to increase the concentration of Agral W.B., and it was also thought advisable to use somewhat more Rape oil. The concentration of the *Pyrethrum* extract, however, was always constant, representing approximately 1 per cent. of the original flowers in the emulsion as prepared for use. The spray mixture for use in the field was therefore prepared as follows: The crude pyrethrins extracted from 200 grams of the flowers (= 2.86 grams of extract in the case of the Dalmatian flowers used) were dissolved in 300 cc. of Rape oil and 100 cc. of Agral W.B. added. When required for use, 20 cc. of this mixture, followed by 5 cc. of 20 per cent. aqueous sodium hydroxide, were added to every litre of water employed. Satisfactory emulsions were then obtained even with quite "hard" water.

A number of small-scale field trials with this mixture have been conducted by Dr. C. L. Walton, and have yielded decidedly encouraging results. Further and larger trials have been arranged for next season. No damage to foliage or flowers was observed, and it was noted that ripe strawberries, after being drenched with the spray, were unaltered in appearance and taste.

English-Grown Pyrethrum.

Trials of the cultivation of *Pyrethrum cinerariaefolium* have been conducted at the Long Ashton Research Station, but the climate here appears to be too damp for the plant to thrive. The crop of flowers obtained during 1927 was so much damaged by the growth of moulds as to render it quite unsatisfactory for use. In order to compare English-grown *Pyrethrum* with the Dalmatian product some flower-buds of plants cultivated at Wye, Kent, were therefore employed.

The material grown at Wye, on extraction with light petroleum, yielded 3.4 per cent. of extract, being more than twice the yield obtained from the Dalmatian flowers. It did not, however, appear to contain any greater yield of the active principles. When the extract obtained from the Wye buds was emulsified in a manner analogous to that employed for the Dalmatian product no difference could be detected in the insecticidal powers of the respective emulsions when they each represented the same weight of the original flowers or buds, although the weight of petroleum extract present differed. The petroleum extract from the Wye buds was a soft, somewhat oily solid and possessed a dark orange brown colour. It was noted that when heated on a water-bath for some time it became almost colourless, but a number of careful tests conducted with the larvae of the early thorn moth indicated that this loss of colour was not accompanied with any diminution of insecticidal power.

A commercial sample of petroleum extract of *Pyrethrum* was also investigated. This product, which represented a known weight of flowers, was dark green in colour and contained considerable chlorophyll. This fact, together with the nature of the solvent present, seemed to indicate that it had been prepared by the treatment of an alcoholic extract of the flowers with petrol. Its insecticidal powers were distinctly less than were those of the products obtained by direct extraction with light petroleum from the Dalmatian flowers or Wye buds.

The ground Dalmatian flowers which had been extracted with light petroleum were then submitted to extraction with ether. The product thus obtained was found, at first, to possess distinct

insecticidal powers. It was ascertained, however, that this fact was due to the presence of some residual amount of the pyrethrins which had escaped solution by the original extraction with petroleum, doubtless owing to the fact that the original flowers had been submitted to but little grinding. The ether extract was dissolved in alcohol, brought on to purified sawdust, the mixture dried and then again extracted successively with light petroleum and ether. The light petroleum removed the small, residual amount of pyrethrins present, after which no insecticidal properties could be detected in the material dissolved by the ether. It is the intention of the present author, however, to conduct some further investigations of the constituents of the *Pyrethrum* flowers which are insoluble in light petroleum in order conclusively to ascertain whether the pyrethrins are the only products present possessing insecticidal powers.

An improved method of obtaining an oil solution of the pyrethrins is under investigation, as is also the question of the employment of an emulsifier which would cause even less rapid hydrolysis than that which takes place in the case of preparations made with the aid of Agral W.B.

Summary.

The active principles present in *Pyrethrum* flowers may be extracted readily by means of light petroleum.

The extracted active principles, when dissolved in a fatty oil, such as Rape oil, may be emulsified conveniently by means of Agral W.B.

An emulsion prepared in this manner, representing a concentration of 1 per cent. of the original flowers, when used as a spray, is rapidly fatal to insects, but causes no damage to vegetation.

THE USES OF NAPHTHALENE FOR THE CONTROL OF CERTAIN PESTS OF MARKET GARDENS.

By L. N. Staniland and C. L. Walton.

Introduction.

In the vicinity of Bristol, there is a considerable area devoted mainly to the growing of Brassicae and celery, these two crops frequently alternating on the same land for considerable periods. As a result, certain of the usual pests of these crops have attained serious proportions, and amongst these may be mentioned *Psylliodes chrysocephala*, a Flea Beetle, the larvae of which tunnel the stems of young cauliflowers, etc., *Ceutorrhynchus pleurostigma*, the well-known Gall Weevil, and *Chortophila brassicae*, the Cabbage Root Fly, these three being pests of the first importance for Brassica growers.

As regards celery, there are two main enemies, *Psila rosae*, the Carrot Fly, and *Acidia heraclei*, the Celery Fly. *Blanjulus sp.* attacking potatoes also demanded attention. There are also several other subsidiary pests which need not be mentioned here. During the period 1926-28, reports regarding serious losses from these pests were received from numerous growers. Investigations showed that the chief losses were due to the three following :— (1) *P. chrysocephala*, which was decimating the Brassicae seed beds, (2) *P. rosae*, which was attacking celery, chiefly when in the same stage, and (3), to a lesser extent, *Blanjulus sp.* at one centre, where the potato crop had been taken without break for a number of years.

In the autumn of 1928 it was resolved to attempt to control the three pests mentioned above, to the satisfaction of the growers, and, since time and circumstances did not allow of the planning of definite field experiments, trials to be carried out by growers were organised.

In view of favourable reports from several sources on the use of naphthalene, notably from the South Eastern and Midland Agricultural Colleges, this substance was selected for the purpose.

This material has long been one of those used against various soil pests, in many cases with but moderate success, and, as a result of recent investigations, we may quote Dr. Tattersfield,*

* F. Tattersfield.—"Annals Applied Biology XV., No. 1. Feb., 1928; pps. 57-80.

who states " Naphthalene either alone or in conjunction with other materials has a certain reputation as a soil insecticide. It has been recommended for use against wire-worms and leather-jackets ; many experiments, however, have shown that its toxic action is uncertain under field conditions."

In the present instance, however, it was planned to use the substance chiefly as a repellent by means of a series of light applications. This system is not new and has been tried with considerable success elsewhere. The object in writing these preliminary notes is to show that satisfactory initial results have been attained by the use of naphthalene and to draw attention to what appears to be a feasible and reasonable way of protecting the crops. Further and more extended trials are contemplated. We understand that other workers have good results to announce.

Methods Employed.

It was decided to use naphthalene of the type known as "Whizzed" which is obtainable in Bristol at about 12/- per cwt. This type of naphthalene has proved to be eminently suitable for broadcasting.

It was recommended to the growers concerned that a series of applications should be made at the rates of 1 oz. per square yard for the initial dressing, and that subsequent applications should be at half that rate. The numbers of applications suggested were one, prior to planting, in the case of potatoes ; three in the case of celery (the first being soon after the seedlings were through) ; whilst for Brassicae, the matter was left to the judgment of the growers. In the case of *P. chrysocephala* the growers at two centres found it necessary to make 6 applications ; one at the 1 oz. rate, and the remainder at the $\frac{1}{2}$ oz., all prior to setting out the plants. For celery the number of dressings varied at the different centres, ranging from three to five, all in the seedling and pricking out stages. For potatoes, only one application was made, at 1 oz. per square yard and dug in.

It was further suggested that, in the case of the celery and Brassicae, an equal amount of fine dry sand (or other material) should be mixed with the naphthalene to facilitate spreading but the growers found this to be unnecessary. These applications were to follow one another at intervals of a week to 10 days.

Four centres were selected, and the whole matter left in the hands of the growers concerned, to whom visits were made from time to time.

Results.

As the result of observations made and reports received from the growers, the following general statements may be made :—

1. *Psylliodes chrysocephala.*

   This pest was satisfactorily controlled at the two centres where it was treated. Subsequent examination after setting out the plants revealed only a few infested Brassicae (cauliflowers) from amongst several thousands.

   At one centre, a decimated seed bed was treated with naphthalene and at once replanted with Brassicae and no infestation resulted.

2. *Psila rosae.*

   Examinations showed that at each centre control had been effected up to the time of setting out. But it may be stated that, at the last visit made, on November 13th, 1928, it was noted that the celery (then being dug for market) had been attacked to a slight extent by the August brood of the pest after earthing up. This had resulted in some "rusting" of the outer green "stems" of otherwise fully developed and healthy plants. As is usually the practice, these were stripped off prior to marketing.

3. *Blanjulus sp.*

   Control was effected.

In addition to the above, it may be added that at one centre, a bed of young cauliflowers was entirely ruined by an attack of the larvae of *Chortophila*. This crop was removed, the ground treated with naphthalene (definite amount not stated) and Savoy plants put in at once, none of which showed any signs of attack.

Conclusions.

The growers are satisfied with the methods of control above described, which have been widely adopted already, and their further development will be watched with interest. It would seem that they are, in all probability, capable of various extensions and modifications, since various growers state that they intend to extend the methods to combat certain of the other pests already indicated.

INVESTIGATIONS ON THE FUNGICIDAL ACTION OF SULPHUR.

III. THE TOXICITY OF SULPHURETTED HYDROGEN AND THE INTERACTION OF SULPHUR WITH FUNGI.

By R. W. Marsh.

In the second progress report on the fungicidal action of sulphur (Annual Report Long Ashton, 1927, p. 72) Professor Barker referred to forthcoming publication of investigations by the present writer on the toxicity of H_2S towards fungi. A full account of these investigations appears as a paper in the "Journal of Pomology and Horticultural Science," Vol. VII., No. 4, 1929, and it is a summarised version of that paper which is here presented.

The Toxicity of H_2S.

Few quantitative data are available concerning the toxicity of H_2S towards fungi, and the opinions expressed on this subject have been contradictory. In the present investigation, the toxicity of gaseous H_2S towards germinating fungus spores was determined under two sets of conditions. The first method was to maintain the spores in a nutrient drop in a large sealed bell jar containing a known concentration of H_2S. A series of experiments made in this way showed that H_2S at a concentration of 1 part in 40,000 parts of air completely inhibited the germination of spores of *Monilia cinerea* and heavily reduced germination in *Monilia fructigena* and *Botrytis cinerea*. At a strength of 1 in 8,000, H_2S completely prevented germination of spores of *Penicillium verdicatum*, *Physalospora miyabeana* and *Botrytis cinerea*. In 1 in 4,000 H_2S no germination of *Fusicladium dendriticum* or *Cladosporium herbarum* spores took place. Tests of this type, made on spores taken at random from a variety of genera, demonstrate that H_2S acts as a general poison, toxic at a low concentration to all the fungi used for experiment. The inhibition of germination was not only a temporary effect but was associated with the death of a large percentage of the spores.

The second method of estimating the toxicity of H_2S was by the passage of an H_2S-air mixture in a slow continuous stream through a small cell containing in a hanging drop the spores to be tested. The evidence obtained from these experiments corroborated that from the previous series in demonstrating the high toxic value of H_2S against the spores employed. For example, it was seen that a flow through the cell of 9.5 ccs. per hour of air containing one part in 3,000 of H_2S was sufficient to inhibit all

germination of the spores of *Monilia cinerea*. In tests of this type the deciding factor appeared to be not the total amount of H_2S passed through the cell but the amount passed per hour.

Arising out of these experiments some tests were made to determine whether a flowering plant would tolerate a concentration of H_2S sufficient to inhibit the germination of fungus spores. It was found that a strawberry plant could be kept overnight without ill effects in an atmosphere containing H_2S in sufficient quantity to inhibit the germination of spores of *Monilia fructigena*. The possibility is therefore suggested of a discrimination of toxic effect as between flowering plant and fungus, if the correct concentration of H_2S is employed.

The Fungicidal Value of the Products from Sulphured Leaves.

In the paper by Professor Barker previously cited, it is fully established that leaves dusted with sulphur under appropriate conditions give off H_2S. In order to determine whether the gas was evolved in quantities sufficient to be toxic to germinating spores, a number of experiments were carried out in which *Monilia* spores were maintained in hanging drops over rings sealed to the sulphured leaf surface. Precautions were taken to prevent the entry of sulphur particles into the drop. The results of these experiments showed that from the sulphured leaves of strawberry, willow and tomato, H_2S was evolved and the germination of spores kept as described over such sulphured leaves was either completely inhibited or greatly reduced. This effect was not produced when the spores were kept over sulphured glass slides. No inhibition was demonstrated using sulphured leaves of black currant, apple, rose and oat.

The Interaction of Sulphur with Fungi.

In the first tests on the interaction of sulphur with fungi, the sulphur was placed on a flat fungus fructification (*Stereum purpureum*) to which rings were sealed as in the leaf experiments described above. Another method employed was to seal the rings over sulphur powdered on to a growth of apple mildew covering a leaf surface. Finally, the sulphur was mixed with a drop containing spores on a glass slide and the ring was sealed over the drop.

When spores of *Monilia cinerea* were kept as described in proximity either to a sulphured *Stereum* fructification or to a sulphured layer of apple mildew, germination of the *Monilia* spores was markedly checked. For the investigation of the effect obtained by keeping spores in proximity to sulphur-spore mixtures, spores from pure cultures of *Monilia fructigena* and *Botrytis cinerea* were taken and set up in glass cells in various combinations, with and without sulphur.

With moist sulphur alone at the base of the cell, and spores of

either fungus above, no inhibition of germination took place. Neither was there any inhibition if *Monilia* spores were grown over *Monilia*, *Botrytis* over *Botrytis*, *Monilia* over *Botrytis*, or *Botrytis* over *Monilia*. If *Botrytis* spores mixed with sulphur were placed at the bottom of the cell, the spores germinated and formed a vigorous mycelium with conidiophores, and no inhibition resulted if spores of *Monilia* or of *Botrytis* were kept at the top of the same cell. But if *Monilia* spores were mixed with sulphur, evolution of H_2S took place, and spores of either genus kept in the same cell germinated very slightly or not at all.

It is therefore demonstrated that the essential difference between a fungus such as *Monilia fructigena*, commonly referred to as "sensitive to sulphur," and one such as *Botrytis cinerea* is that a mixture of moist spores of the former with sulphur produces H_2S, while spores of the latter produce no such effect. The toxicity of H_2S to these two fungi does not differ appreciably: the contrast between them lies in their ability to react with elemental sulphur.

The hypothesis is therefore put forward that sulphur is toxic to fungi in these cases by virtue of the H_2S produced from it: that the production of H_2S from sulphur can be brought about by certain living organisms, and that a fungus "sensitive to sulphur" is one which can act upon the sulphur to produce H_2S. The germinating spore of such a fungus, on coming into contact with a sulphur particle, exercises a self-poisoning effect, analogous with that produced by fungus spores acting on the precipitate from Bordeaux mixture.

Hence, when sulphur is placed on a flowering plant which also bears fungus spores or mycelium, the possibility of a dual action must be considered. Both the fungus and the green plant may be active towards the sulphur, that is, may react with the sulphur to form H_2S, as suggested above. Again, both plant and fungus may be inactive, or one may be active and the other not. Thus, the growth of a fungus such as *Botrytis cinerea*, inactive towards sulphur, might be inhibited if on a sulphured plant capable of giving rise to H_2S, while the same fungus on another host might not be affected by sulphur. To what extent H_2S, produced by green leaves growing under open-air conditions, is operative has still to be ascertained, but, under greenhouse conditions, the H_2S produced by the plant may be an important factor.

As the reactions of the green plant with sulphur remain under examination, a discussion of the possible methods of action of the germinating spore cannot usefully be included at this stage. It is hoped, however, that with the elucidation of the mechanism of the leaf-sulphur reaction, some light will also be thrown on the method of interaction of sulphur with fungi.

A PRELIMINARY NOTE ON THE CONTROL OF BLACK CURRANT LEAF SPOT (PSEUDOPEZIZA RIBIS).

By R. W. Marsh and J. G. Maynard.

The seriousness of the leaf spot disease of black currants in this Province was first pointed out by Briton-Jones in 1925 (1). Since that year, outbreaks of the disease have become general in all currant-growing areas and numerous inquiries have been made for particulars relating to control measures. As far as the authors are aware, no results of any successful control of this disease by spraying have yet been published in this country. It has therefore been decided to set forth the information obtained in trials made at Long Ashton in 1928, without claiming that this gives more than an indication of the lines along which subsequent experiments will be carried out. Until such trials are made it is obvious that the value of the results obtained cannot be satisfactorily estimated.

In all, three trials of spray applications were made at Long Ashton during 1928. Of these, the first two showed little promise, and only the third will be described in detail. The first spraying was made on the variety Baldwin with 1 in 12 lime sulphur solution on March 30th. It was thought that this spray (which was primarily a control measure against Big Bud (*Eriophyes ribis*) might also have some effect in preventing infection of the leaves with the leaf-spot fungus, *Pseudopeziza ribis*, but comparison with control rows showed that lime sulphur at this stage gave no control of leaf spot whatsoever.

The second trial was made with a block of bushes of the resistant variety French, growing under apples. This block was sprayed on April 2nd with Bordeaux mixture and also received spray drift from the Bordeaux sprayings of the apples on April 13th and May 31st. No leaf spot developed, but this treatment left obvious spray residue on the fruit and cannot therefore be recommended.

The final trial was made on a large plot of 4.3 acres (approximately 3,500 bushes) mainly of the variety Baldwin. The other

varieties present, namely French, Victoria, Boskoop, September Black, The Brodie, Blacksmith, Black Grape and Edina, developed the disease very slightly or not at all, and the observations on the control of the disease are confined to the Baldwin block. At the time of picking, the disease had already started to develop. Most of the older leaves showed spots, but no defoliation had set in and the young leaves were generally clean. On July 20th, *i.e.* immediately after picking, the whole plot was sprayed, with the exception of a block of 186 bushes of Baldwin left as a control. Approximately half the plot was sprayed with a 4-4-50 Bordeaux mixture : the remainder of the sprayed bushes received a 2-4-50 mixture. In this second group the attempt was made on a block of 340 bushes to spray the leaves on the undersides only. The applications were all carried out using a Herrod's Demon Hand Sprayer with two nozzles.

Within a month, the efficacy of the treatment was apparent. By August 29th, when the photographs facing page 110 were taken, the lower halves of the bushes in the control were destitute of leaves, while such leaves as remained were almost entirely withered by the attacks of the leaf spot fungus. The sprayed rows, on the other hand, showed no defoliation whatever, and the existing spots on the older leaves had apparently made no further progress. No variations due to the different methods and strengths of spraying could be determined. Figures 1 and 2 facing page 110 show a sprayed and a control bush respectively, and Figure 3 is a general view of part of the plot showing the control bushes in the foreground and, behind, the block sprayed with 4-4-50 Bordeaux. The contrast shown by these photographs became even more striking on the plot during September when the unsprayed bushes were absolutely bare while the treated rows retained their leaves until the normal time of shedding. We are indebted to Dr. Swarbrick for the information that it is in the period from early August onwards that the leaves of the black currant exert their greatest effect in the building up of the plant's reserves for the following year : the prevention of premature defoliation during this period is therefore of the greatest importance. In the Long Ashton trial the vigour of the sprayed and unsprayed bushes, respectively, will be compared in 1929, but some indication of the differences in the available reserves of the two sets of bushes could be found during the winter of 1928 by comparing the size of the buds formed on the wood of that year. The following table gives details of measurements of buds made on November 8th :—

FIG. 1.
Bush sprayed July 20th with Bordeaux mixture.

FIG. 2.
Control Bush (unsprayed).

Fig. 3.
View of plot showing control bushes in foreground; sprayed bushes beyond.

	From Unsprayed Bushes.			From Sprayed Bushes.		
	Min.	Max.	Average.	Min.	Max.	Average.
Length of 20 buds taken at random (cm.)	.63	.97	.80	.69	1.04	.85
Breadth of 20 buds taken at random (cm.)	.20	.33	.28	.27	.42	.32
Weight of 1,000 buds taken at random..	Total 36.37 gm.			Total 41.93 gm.		

The buds from the sprayed plots are thus seen to be 15.3% heavier than those from the unsprayed. Crop weight figures on these plots will be obtained during 1929, and, judging from the differences found in the buds, it is expected that these will emphasise further the value of the post-cropping spray in 1928.

REFERENCE.

(1) Briton-Jones, H. R. A Note on the Leaf Spot Disease of Black Currants. *Long Ashton Annual Report*, 1925., pp. 105-108.

SPRAYING TRIALS AGAINST APPLE SCAB AT LONG ASHTON IN 1928.

By J. G. Maynard and R. W. Marsh.

In modern fruit plantations in this country, the general principle that apple scab can be controlled in most seasons by spraying has now been amply demonstrated. The consequent extended use of Bordeaux and lime-sulphur sprays has in its turn raised another problem ; that of spray damage. In this Province it is apparent that this problem now exercises the minds of growers more than any other aspect of scab control. The standards of safety usually given for spray fluids are, for the most part, based on the results of trials made in the east and south-east of England ; there appears to be little doubt that these standards are not invariably a trustworthy guide under the different conditions often experienced in the West. The necessity has therefore arisen for determining in this Province what is the tolerance of the commonly grown varieties of apples towards the standard fungicides and, further, whether there are satisfactory alternative spray fluids which would obviate the danger of damage.

In the first of the trials, described in this paper, Bordeaux mixture was used as the standard fungicide, while a commercial brand of " colloidal " sulphur was employed for comparison. In the previous season, this brand (used according to the maker's recommendations) had not given a good control of scab but it had caused no spray damage at a time when Bordeaux spraying had led to fruit cracking ; it was therefore given a further trial in 1928 at twice the strength used the previous year.

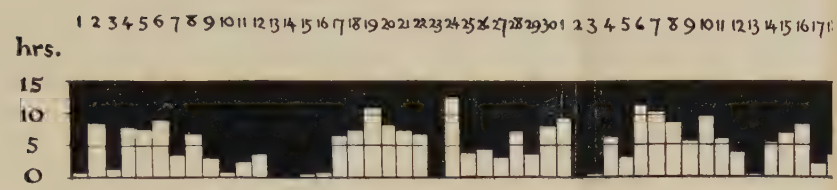
In an attempt to keep an account of the total expenditure on spraying during these investigations, details were secured of the amounts and costs of materials, the number of men employed, hours worked, and the costs of haulage, etc. The figures are simply placed on record without analysis in the hope that, when several additional records of this type are available, some adequate basis may be provided for deductions concerning the costs of different spraying processes.

The Plots.

The trials were carried out entirely in the Long Ashton plantations, where the following plots were available :—

METEOROLOGIC

LONG ASHTON APRIL 1



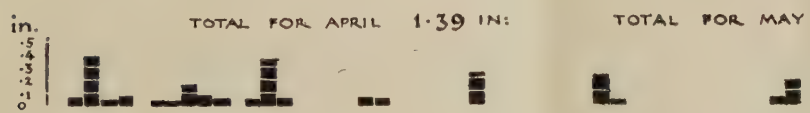
SUNSHI

Single line – velocity < 10 m.p.h.
Double line – velocity 10–20 m.p.h.

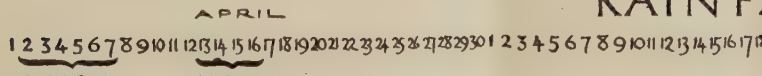
WIN

Upper line - daily maxima

TEMPERA



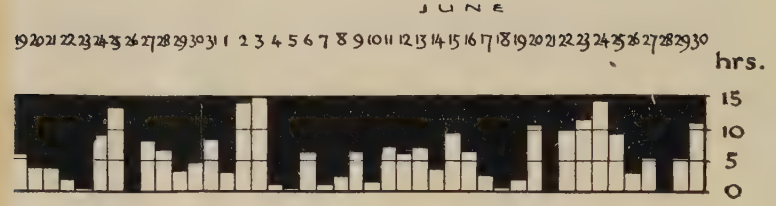
RAINFA



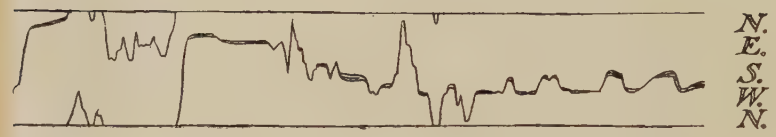
PRE-BLOSSOM SPRAYS APPLIED

AL DATA

– JUNE 30, 1928



NE

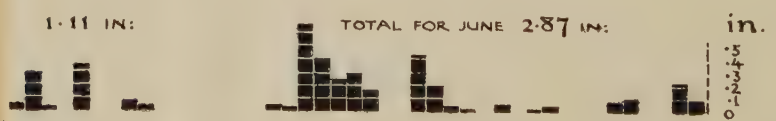


Three lines ~ velocity 20-30 m.p.h.
Four lines ≈ velocity 30-40 m.p.h.

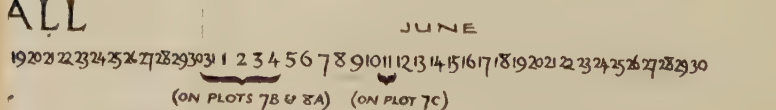
D

TURE

Lower line – daily minima



ALL



POST BLOSSOM SPRAY APPLIED

Plot 7b (1.75 *acres approx.*)

Laid out in 1920 as a stock trial, this plot is planted with twelve rows of trees, the whole of each row being on one of the Malling layered stocks I to XIII (with certain exceptions) or on the Bristol stock G.8. A row comprises first eight trees of Bramley Seedling, next eight of Worcester Pearmain, then eight of Lane's Prince Albert. Each variety therefore forms a homogeneous block of eight trees by twelve. The trees are planted on the square at 15 feet and intercropped with currants ; the ground is clean cultivated. The size of the trees is shown by the following table :—

TABLE I*a*.

*Variety.**	*Average Height.*	*Average Spread.*
Bramleys	11ft.	9ft.
Worcesters	8ft.	6ft.
Lanes	9ft.	8½ft.

Plot 7c (2.25 *acres approx.*).

This includes a small block of 24 Worcester Pearmain, a block of 40 Lane's Prince Albert and 45 others of this variety (all planted in 1919) ; a block of 50 James Grieve (planted 1918), 21 trees of Bramley Seedling, and rows of several other varieties, including Allington Pippin, Stirling Castle, Cox's Orange Pippin, and Edward VII. All the trees are planted on the square at 15 feet, and the whole plot is under clean cultivation with no undercrop. The size of the trees in this plot varies between a maximum of 17ft. height by 16ft. spread (Bramley) and a minimum of 7½ft. height and 5½ft. spread (Lord Hindlip). The block of James Grieve, which may be taken as representative of the intermediate varieties, shows an average height of 9ft. and a spread of 8½ft.

Plot 8a (2.25 *acres approx.*).

This plot consists simply of alternate rows of Allington Pippin and Edward VII, planted 1920, there being 13 rows in all, each of 26 trees. The trees stand at 15 feet square, and are growing under conditions of clean cultivation without undercrops. The heights and spreads are as follows :—

TABLE I*b*.

Variety.	*Average Height.*	*Average Spread.*
Allingtons	9½ft.	12ft.
Edwards	10ft.	9½ft.

The arrangement of the spraying trial was severely limited by the fact that, owing to other experiments in progress, no differential

* Abbreviated forms are frequently used for variety names many times repeated.

treatments could be given within any one plot. A whole plot had therefore to be taken as a unit for spraying treatment, and the only possibilities of comparison lay where a variety was represented on more than one plot. Thus it was necessary that the Lanes, Worcesters and Bramleys on plot 7*b* should receive all the same treatment, but some measure of comparison could be made by giving another treatment to the same varieties on plot 7*c*. Similarly, possibilities of comparison existed between the Edwards and Allingtons of plot 7*c* and those of plot 8*a*. The only exception was made in the case of Cox's Orange Pippins on plot 7*c*, where half the row was given a treatment differing from that of the remainder of the plot.

The limitations stated above similarly made it impossible to provide strict controls. A row of Lane's Prince Albert of comparable size and age in an adjoining plot was left unsprayed to give some indication of the normal incidence of scab in 1928 but, as previously stated, the main object of the trial was not to restate a verdict in the matter of spray versus no spray but to obtain information on the subject of damage.

The programme for the trials was designed to give all the plots the same pre-blossom sprayings and, in the post-blossom treatments, to compare as far as possible the effect of a weak Bordeaux spray with that of the colloidal sulphur. The arrangement was as follows :—

Pre-blossom sprays :—Two applications of excess-lime Bordeaux mixture (4-8½-50) on all plots.

Post-blossom sprays :—A. Two applications of excess-lime Bordeaux mixture, half strength (2-5-50) on plot 7*b* (Bramleys, Worcesters and Lanes) ; plot 8*a* (Allingtons and Edwards) ; part of plot 7*c* (half the row of Cox's).

B. Two applications of colloidal sulphur, double strength (10-100), on all the remainder of plot 7*c* (Bramleys, Worcesters, Lanes, Allingtons, Edwards, Cox's, Grieves, Stirlings, etc.).

In carrying out this scheme, as it was found that scab was so effectively controlled by the first three applications, the second post-blossom spray was omitted.

Conditions Before Spraying.

The 1927 season was marked by a very heavy infestation of scab. In the plots under discussion no effective control was obtained on plots 7*b* and 7*c* and only a partial control on 8*a*. During the winter the plots received the usual cultivations ; plot 7*b* was dug in February and 7*c* was disced in February-March. All the trees were winter washed with Mortegg in January. At various dates in March, a survey was made of the amount of scabbed wood present and the position was found to be as follows :—

Table II.

Plot.	*Variety.*	*No. of trees.*	*No. showing scabbed wood.*	*Notes.*
7*b*	Bramleys ..	96	0	Pruning on this plot always left until the pink blossom stage so that counts of the total blossoms can be made.
	Worcesters ..	96	90	
	Lanes ..	96	66	
7*c*	Bramleys ..	21	0	
	Lanes ..	40	27	Long spurs.
	Lanes ..	45	2	Short spurs.
	Worcesters ..	24	21	All with relatively short spurs. Pruning carried out in the winter.
	Cox's	14	6	
	Edwards ..	10	0	
	Allingtons ..	15	0	
	Grieves ..	50	44	
	Stirlings ..	12	4	
8*a*	Allingtons ..	156	14	Bordeaux spray in 1927 moderately effective. Pruning practically confined to thinning.
	Edwards ..	182	2	

During the same period, a careful search was made for overwintered scabbed leaves which might have survived the cultivations given to the plots. No affected leaves were found so, on the plots concerned, the scabbed twigs remained the only visible source of infection.

Pre-Blossom Sprays.

The first pre-blossom spray was applied between the 2nd and the 7th April to all varieties on plots 7*b*, 7*c* and 8*a* with the exception of the Edwards. The last-named being of a late-blossoming habit, were not sprayed until April 14th. The second pre-blossom spray was applied on April 13th-16th, again to all varieties exceptEdwards, which received their second spraying on May 4th-5th.

The spray fluid employed throughout was an excess-lime Bordeaux mixture made up in the following proportions :—4 lbs. copper sulphate, 8½ lbs. lime, 50 galls. water. This was applied with spray guns so that the trees received a drenching spray rather than a "fog." Full details of quantities and costs are given in Table VI.

In general, the outfit operated during the pre-blossom treatments was a Herrod's 3½ h.p. spray tackle with 4 guns working at 200 lb. pressure. The guns were fed direct through hose (2 lengths of 20ft. and 2 of 30ft.), and the machine was in almost constant motion, being drawn by a Fordson tractor. An exception to this method of working was made on plot 7*b*, which, being intercropped with currants, was served through an ordinary lay-out of mains. As a supplementary outfit, a headland sprayer was used occasionally as circumstances demanded.

The spray fluid was mixed at the nearest point where water was available, 200-300 yards from the plots, and hauled to the sprayer in a horse-drawn tank. Labour employed on attending the spraying engine, tractor, tank and mixing is entered as " attendant labour " in Table VI, which gives a complete statement of labour and transport costs.

Weather.

Before considering spray damage, it is necessary to give some account of the unusual weather conditions during and following spraying (see Fig. 1). The weather on April 2nd was fair with a light wind ; the following day was wet (.36in. rain) and no spraying was possible. The 4th and 5th were again fair with moderate south-westerly winds. On the 6th the wind changed, and the spraying on the 7th was carried out in a moderate easterly wind. During the following week there were strong north-easterly winds, a falling temperature and little rain.

Between the first and the second sprayings, the inclement weather, characterised by cold, drying winds, was markedly unfavourable to growth, and the unfolding of the buds made little progress. While the second spraying was proceeding (13th-16th April), the temperature continued to fall, the prevailing wind was E.N.E. (reaching gale force on the 14th) and there was no sunshine. On the 14th there was a fall of rain and sleet (.36in.), and snow was lying on the morning of the 15th. The week following was a period of unusual cold, with low rainfall, south-westerly winds and moderate sunshine. Towards the end of April the temperature rose, but the weather continued dry with prevailing easterly winds.

May 4th was fair with a light N.E. wind : May 5th was calm in the morning with a thunderstorm later. The following three weeks were exceptionally dry with light, variable winds and a generally low temperature. Not until the end of the month did the temperature show a definite rise.

Spray Damage.

As there was so little growth between the first and the second sprayings, the effects of these two treatments upon the trees may justifiably be considered together. Table No. III (following) gives details of the varieties, the stages at which they were sprayed and the amount of damage resulting. The nomenclature for the stage of development of the opening buds is that proposed by Briton-Jones and Lees (1).

TABLE III.

Variety.	*Plot.*	*Stage at time of first spraying.*	*Stage at time of second spraying.*	*Damage recorded up to end of April.*
Bramleys	7*b*	green flower		Scorch of young bud clusters frequent.
Bramleys	7*c*	green flower		Scorch of leaf and bud tips occasional.
Lanes	7*b*	burst	green flower	Occasional bud clusters scorched : moderate leaf tip scorching.
Lanes	7*c*	burst	green flower	Slight scorch of leaf and bud tips frequent.
Worcesters	7*b*	bursting	burst	None.
Worcesters	7*c*	bursting	burst	None.
Allingtons	7*c*	green flower		Occasional scorch of leaf tips.
Allingtons	8*a*	green flower		Slight scorch of leaf and bud tips frequent.
Cox's	7*c*	green flower		None.
Grieves	7*c*	green flower		Occasional bud clusters badly scorched.
Stirlings	7*c*	green flower		None.
Edwards	8*a*	burst	green flower	None (recorded up to May 20th).

POST-BLOSSOM SPRAY.

The post-blossom spray was applied between May 31st and June 4th to all varieties on plots 7*b* and 8*a* and to half a row of Cox's on plot 7*c*. These trees all received an excess-lime Bordeaux spray made up in the following proportions :—2 lbs. copper sulphate, 5 lbs. lime, 50 gallons water. The remainder of plot 7*c* was sprayed on June 11th with a colloidal sulphur spray made up in the proportions of 10 lbs. of colloidal sulphur and 5 lbs. of soft soap to 100 gallons of water. Details of the total quantities and costs of materials are given in Table VII.

As in the pre-blossom sprayings the Herrod's power sprayer was employed, but, as the tractor was not available, mains were laid in all the plots. The headland sprayer was used occasionally, as before. The arrangements for filling and mixing were as in

the pre-blossom treatments. Labour and transport costs are set out in full in Table VII.

Weather.

The period between May 31st and June 3rd was one of sunshine, moderate N.E. winds and no rain. On the 6th, however, the wind changed definitely to S.W., and 2.33in. of rain fell during the ensuing nine days. June 11th was dry, fair and cool with a moderately strong S.W. wind. During the second half of June winds continued mainly S.W., increasing in strength towards the end of the month, with rising temperature, little rainfall and moderate sunshine.

Spray Damage.

The damage recorded as resulting from the post-blossom spray is listed below :—

TABLE IV.

Variety.	*Plot.*	*Spray fluid employed.*	*Damage.*
Lanes	.. 7*b*	Bordeaux 2-5-50	Leaf spotting.
Worcesters	.. 7*b*	ditto	Slight leaf spotting : very infrequent cracking of fruit.
Bramleys	.. 7*b*	ditto	Slight leaf spotting, 0.73% of fruit russetted.
Cox's ..	.. 7*c*	ditto	Leaf spotting, moderate defoliation.
Allingtons	.. 8*a*	ditto	Slight leaf spotting.
Edwards	.. 8*a*	ditto	Spotting. Some defoliation and a large amount of bronzing of leaves.
Lanes	.. 7*c*	Colloidal sulphur 10-100	Moderate to heavy defoliation : 70% fruit drop in the second week following spraying.
Worcesters	.. 7*c*	ditto	None.
Bramleys	.. 7*c*	ditto	Slight leaf bronzing. No russetting of fruit.
Cox's ..	.. 7*c*	ditto	Leaf spotting, slight defoliation.
Edwards	.. 7*c*	ditto	None.
Allingtons	.. 7*c*	ditto	None.
Grieves	.. 7*c*	ditto	20% fruit drop in second week following spraying.
Stirlings	.. 7*c*	ditto	Very heavy defoliation.

The question of spray damage is again referred to later.

YIELD OF CLEAN AND OF SCABBED FRUITS.

Throughout the season, it was exceedingly difficult to find scabbed leaves on the sprayed plots and, after the third spraying, the trees appeared so clean that no further treatment was given. A crop was obtained from all the varieties mentioned in this paper with the exception of Stirlings and Cox's. On picking, the total number of fruits was recorded, and also the number which showed any scab whatsoever. In no case was the scab attack on the

sprayed plots so bad as to cause cracking and, on many of the fruits listed as scabbed, the disfigurement was quite inconspicuous. The detailed figures are as follows :—

TABLE V.

Plot.	*Spray Treatment.*	*Variety.*	*Total Fruits.*	*Scabbed Fruits.*	*Per cent. Scabbed.*
7*b*	Bordeaux 4-8½-50	Lanes	10,451	75	0.74
	(twice) followed by	Worcesters	6,294	14	0.22
	Bordeaux 2-5-50	Bramleys	3,852	0	0.00
7*c*	Bordeaux 4-8½-50	Lanes	79	1	—
	(twice) followed by	Lanes	749	5	0.67
	colloidal sulphur	Worcesters	1,589	42	2.63
	10-100	Bramleys	1,821	9	0.49
		Grieves	2,415	144	5.96
		Allingtons	251	3	1.20
		Edwards	845	1	0.12
8*a*	Bordeaux 4-8½-50 (twice), followed by	Allingtons	24,583	482	1.98
	Bordeaux 2-5-50	Edwards	1,734	64	3.84
7*a*	Control row	Lanes	818	327	40.00

Of the 327 scabbed fruits in the control row, 184 were slightly scabbed and 143 badly attacked

Subsequent Scab Infection.

On plot 7*b* an examination for scabbed wood made during December 1928 disclosed that only 16 trees of Worcester Pearmain and none of Lane's Prince Albert showed any scab-infected wood of the current year. The sources of infection for 1929 have therefore been considerably lessened.

GENERAL REVIEW.

The weather conditions of 1928 were such that scab control was relatively easy to obtain : at the same time, the observations both at Long Ashton and elsewhere showed that where spraying was neglected the outbreak of scab was sufficiently serious to cause marked depreciation in the quality of the fruit. In the spraying trials just described the actual control of scab was generally of a very high order, the numbers of clean fruits averaging over 99 per cent on all the sprayed plots combined. The feature of the spraying programme was the early and very thorough application of the pre-blossom sprays. These two sprays, in actual fact, approximated very nearly to a double spray given at the " green flower " stage, so little was the amount of growth between the two sprayings. This early and heavy application of Bordeaux mixture effectively stopped the first infection of the leaves from the twigs and undoubtedly contributed very largely to the success of the scab control.

Considering the two types of post-blossom spray from the fungicidal point of view, there is little to choose between them,

although there is a slight advantage in favour of the Bordeaux. It should be stated, however, at this point, that the trees treated with the copper fungicide were found in December 1928 to be harbouring large quantities of red spider eggs, while those treated with the sulphur spray remained relatively free.

On the subject of spray damage, the results obtained were of great interest. Following the pre-blossom applications, Bordeaux injury was recorded on Bramleys, Lanes, Allingtons and Grieves. It must be pointed out, however, first, that the Bordeaux mixture was applied more generously than is usual and, secondly, that this injury had no lasting detrimental effect on the tree and, indeed, ceased to be noticeable after a few weeks. In the post-blossom spraying, the damage caused by colloidal sulphur on certain varieties was far more serious. On Stirling Castle the trees were from one-half to two-thirds defoliated and remained crippled throughout the season : on Lanes there was also marked defoliation and, on one block, 70 per cent. fruit drop in the first fortnight after spraying. The shedding of fruits on this block continued until, by the time of picking, 30 trees out of 40 were entirely bare of fruit and the remainder had each lost at least 90 per cent. of the total fruits set. The fruit drop on Grieves was possibly greater than one would have expected from an unsprayed tree but, in the absence of any differential treatment, no certain conclusion can be drawn for this variety. The effect of sulphur sprays on Stirling Castle has previously been recorded (2) and examples were seen during the summer elsewhere in the Province. With regard to Lanes, the position is not so clear since, in a Herefordshire orchard in 1928, a colloidal sulphur spray at the 5-100 strength was used on this variety in the post-blossom stage with impunity and gave satisfactory control of scab. It is hoped to make further investigations on this point.

It is not yet known to what extent spray damage is conditioned by the rate of growth of the parts of the plant subjected to spraying. In the experiments under discussion, the time of application of sprays happened to coincide with periods when growth was severely checked, principally by unfavourable winds, and it is suggested that this coincidence may be not without bearing on the general question of spray damage. Further work on this hypothesis is in progress.

The figures relating to costs of spraying have been made as complete as possible, since the sources of information on this subject (3) (4) are still few. Figures for depreciation of plant have not been given but, to counterbalance this, the labour cost has been placed at 10d. per man-hour, which is a high estimate for the West of England. The gallonage figures are above those given

by other writers (3); there is little doubt that this is due to windy weather at the time of spraying and the insistence on thorough application. In spite of this, it will be seen that the cost of materials is generally only about one-third of the total cost. (The colloidal sulphur spray is an exception, but it must be remembered that this was made up at double strength.) Effective economy in spraying costs can therefore be looked for only in the direction of reduced labour charges: this consideration gives an additional advantage to the use of power sprayers.

The writers wish to express their appreciation of the whole-hearted co-operation of the plantations staff both in carrying out the trials and in preparing the records for publication. In particular, their thanks are due to Mr. C. R. Thompson and Mr. G. Clothier, who supplied the figures of crop weights, to Mr. H. Locke for weather records, and, especially to Mr. J. E. Young, Plantations Foreman, who was responsible for the preparation and application of the spray fluids and for the recording of all the data relating to costs.

Summary.

1. Detailed observations on scab control, spray damage and costs of spraying were made on plots of commonly-grown apple varieties at Long Ashton during 1928.

2. The treated plots received two pre-blossom applications of excess-lime Bordeaux mixture followed by a post-blossom application of either (1) weak Bordeaux mixture or (2) double-strength colloidal sulphur.

3. The yield of clean fruit on all the treated plots was between 94 and 100 per cent. Adequate controls could not be provided, but a check row of one variety showed only 60 per cent. of clean fruit.

4. Data are presented relating to Bordeaux injury and to serious damage caused by colloidal sulphur to the varieties Stirling Castle and Lane's Prince Albert. The relation of this damage to weather conditions is discussed.

5. Costs of the spraying trials are set forth in detail, and it is demonstrated that a relatively high proportion of these costs is accounted for by labour charges.

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2. Frampton, A. M. A Preliminary Report on the Incidence and Control of Apple Scab and Apple Mildew.—*Ann. Rept.* 1926 and 1927. II. Supplement. *East Malling Research Station*, p. 107 (1928).
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TABLE

COMBINED COSTS OF THE TWO

Plot	No. of Trees	Dates	Spray Fluid	Materials									Total Cost of Materials	Cost per Tree	Gall. per Tree
				Copper Sulphate		Lime		Colloidal Sulphur		Soft Soap		Water			
				Amt.	Cost	Amt.	Cost	Amt.	Cost	Amt.	Cost				
1	2	3	4	5 lbs.	6	7 lbs.	8	9 lbs.	10	11 lbs.	12	13 galls.	14	15	16
7*b*	288	April 2, 4, 14, 16,	Bordeaux 4-8½-50	116	43/6	246	12/8	—	—	—	—	1450	£2 16 2	2.3d.	5.0
7*c*	445	April 5, 13, 14	ditto	148	56/8	314	15/2	—	—	—	—	1850	£3 11 10	1.9d.	4.2
8*a*	338	April 14, May 4, 5	ditto	120	45/-	273	14/-	—	—	—	—	1500	£2 19 0	2.1d.	4.4

TABLE

COST OF THE SINGLE POST-

Plot	No. of Trees	Dates	Spray Fluid	Materials									Total Cost of Materials	Cost per Tree	Gall. per Tree
				Copper Sulphate		Lime		Colloidal Sulphur		Soft Soap		Water			
				Amt.	Cost	Amt.	Cost	Amt.	Cost	Amt.	Cost				
1	2	3	4	5 lbs.	6	7 lbs.	8	9 lbs.	10	11 lbs.	12	13 galls.	14	15	16
7*b*	* 294	May 31, June 1	Bordeaux 2-5-50	32	12/-	80	4/-	—	—	—	—	800	16 0	0.7d.	2.7
7*c*	* 439	June 11	Colloidal Sulphur 10-100	—	—	—	—	110	146/8	55	11/3	1100	£7 17 11	4.3d.	2.5
8*a*	338	June 1, 2, 4	Bordeaux 2-5-50	48	18/-	180	8/3	—	—	—	—	1200	£1 6 3	1.0d.	3.5

SUM-

TOTAL COSTS PER PLOT OF

7*b* Pre £8 16 10½
Post £2 16 0½
£11 12 11

= 10d. per tree
£6 13 0 per acre

7*c* Pre £10 7 9
Post £11 10 6½
£21 18 3½

= 1/- per
£9 15 0

* 6 Cox's on 7*c*

VI.

PRE-BLOSSOM SPRAYINGS.

Labour						Transport					Total Cost of Labour, Materials and Transport	Cost per Tree	Remarks.
						Tractor		Horse					
Man-Nozzle Hours.	Horseman Hours	Attendant Hours	Hours Waste Time	Total Man-Hours	Total Labour Cost (at 10d. Hr.)	Hrs.	Cost (at 2/- Hr.)	Hrs.	Cost (at 1/- Hr.)	Total Transport Costs			
17	18	19	20	21	22	23	24	25	26	27	28	29	30
68½	18	36½	—	123½	£5 2 8½	—	—	18	18/-	18 0	£8 16 10½	7.4d.	One spraying of the inter-cropped black currants included.
71	8	26½	10	126½	£5 5 5	11½	22/6	8	8/-	£1 10 6	£10 7 9	5.6d.	
66½	11	24	12	128½	£5 6 8½	15	30/-	11	11/-	£2 1 0	£10 6 8½	7.3d.	Delay owing to temporary breakdown.

VII.

BLOSSOM SPRAYING.

Labour						Transport					Total Cost of Labour, Materials and Transport	Cost per Tree	Remarks.
						Tractor		Horse					
Man-Nozzle Hours	Horseman Hours	Attendant Hours	Hours Waste Time	Total Man-Hours	Total Labour Cost (at 10d. Hr.)	Hrs.	Cost (at 2/- Hr.)	Hrs.	Cost (at 1/- Hr.)	Total Transport Costs			
17	18	19	20	21	22	23	24	25	26	27	28	29	30
24½	6½	9½	—	40½	£1 13 6½	—	—	6½	6/6	6 6	£2 16 0½	2.3d.	
39	9½	12	5½	75½	£3 3 1½	—	—	9½	9/6	9 6	£11 10 6½	6.2d.	
47½	4½	18½	—	71	£2 19 2	—	—	4½	4/9	4 9	£4 10 2	3.2d.	

MARY.

ALL SCAB SPRAYINGS.

8*a* Pre £10 6 8½
Post £4 10 2
£16 16 10½

= 10½d. per tree
£7 10 0 per acre

tree
per acre

included with 7*b*.

THE ECONOMICS OF SPRAYING FRUIT TREES.

I. THE COST OF WINTER WASHING—WINTER 1928-29.

By J. G. Maynard.

Introduction.

Spraying is recognised as an essential part of the routine operations on any farm where a serious attempt is being made to grow fruit for profitable sale in the English market. In the writer's opinion, this operation is of paramount importance in the production of top fruit in many fruit growing districts and might well be given precedence over cultivation in budgetting expenditure in plantations that are established and are not carrying an undercrop of soft fruit. Very little information (1) is available as to spraying costs as yet, and it is with a view to increasing this information and to promoting discussion in the matter of spraying technique that this article is written.

A rather lengthy preamble to the data relating to actual costs of spraying appears necessary, since a mere statement of cost without knowledge of the main conditions prevailing on the farm would be of little value, and for this reason the layout of the farm and the details of the spraying equipment, etc., are described at considerable length.

The Farm and Equipment.

The Long Ashton Farm on which the data have been collected, for the purpose of this study, may be considered to approximate fairly closely to many medium-sized fruit farms. The fact that the plantations are laid out for sundry experimental purposes does not seriously affect the issue of the cost of spraying as this is carried out as a routine operation over the whole farm under conditions approximating to those prevailing on any commercial fruit farm. The main difference between conditions at Long Ashton and on most commercial farms is the fact that, of necessity, individual plantations are rather small and therefore the cost may be rather high due to the increased moving of tackle required.

(1) Turnbull, J.—"Modern Fruit Tree Spraying and What it Costs."—*Min. Agric. and Fisheries*, Misc. Pub. No. 58, 1927.

The material in the plantations from which data have been obtained varies from 25-year-old standard apples to pruned black currants one year from planting out, and includes a considerable area of apples about ten years old, a number of plums from ten to fifteen years old, as well as young mixed plantations, and an acre or two of soft fruit only. The material, in fact, approximates fairly closely to that which may be seen on many commercial farms.

FIGURE I.

P Pond.
B Buildings with piped water supply.
— Metalled road. N.B.—That shown by plots 6 to 10 is not yet built.
= Tracks not metalled.

The plan (Fig. 1) shows the layout of the farm, the general shape of which is probably no more inconvenient or uneconomic than that of many holdings of a similar size. The length of good road is greater than that to be found on many farms. At the east end of the farm, on the south of the railway, there are no roads (the one indicated on the plan has not yet been made), and water carting is almost always difficult in the winter, as even tracks between plantations are very much cut up, being used as tractor headlands all the year round and continually stirred all summer while turning a ten-foot double row disc harrow. All the plantations, with the exception of the old standard orchard No. 1, and some grass strips on No. 11, are cultivated. The sources of water supply are fairly good, probably better than those on many farms. On the north of the railway, two taps from the high pressure main make the rapid mixing of spray fluid a simple matter and little carting is involved. On the south of the railway where the main plantations are, there is one low pressure tap at the buildings, which passes only about 100 gallons in 30 minutes, and the pond. This pond takes the surface water from a good deal of the surrounding land, and the water is very soft and much better for spray mixing than the hard water from the taps. It was very small until cleared out and deepened during dry weather in the summer of 1928, the bottom being "puddled." As well as improving drainage in the vicinity, it now acts as a useful reservoir for spray water and saves considerable cartage. The stream at the east end of the farm is very little used at present for spray water, and for the purpose of the present article it can be ignored.

On the south side of the railway the major problem in spraying until recently has been to get the water quickly enough to serve the nozzles. The low pressure tap running about 200 gallons an hour was not enough either to keep the water cart going without stops or the spraying gang working continuously. This difficulty has been overcome in the following way: Two large corrugated tanks, each holding about 150 gallons, have been fixed to a scaffolding made with about eight old railway sleepers bolted together (Plate 1); the total cost of this erection was trifling, the work being carried out one wet day. A pipe that can be connected with the existing low pressure tap was run for a few yards under ground across the roadway then up the scaffolding projecting over the first tank; an old piece of guttering serves to carry the water into the second tank when the first tank is full. When the weather is not frosty the tanks can be filled overnight to give spraying water early next morning; in frosty weather someone is detailed to start filling the first tank early and, by the time the machine is ready for work and the horses out from the stable, one tank is generally full and the second one in process of filling.

Each tank is fitted at the bottom with a two inch " treacle tap." The water cart can be backed right under the tap (Plate 1) and is filled with about 100 gallons in a little over one minute. The force of passing this volume of water into the cart so quickly has proved of the utmost value in mixing the spray thoroughly. This rapidity of filling water carts has certainly saved the cost of the erection, materials and tanks in a year, and the arrangement might be considered with advantage on farms where somewhat similar conditions exist.

One further method of increasing efficiency in handling water is in use, namely a fairly large semi-rotary pump is bolted to the side of the water cart. By using short lengths of rubber hose, the water cart can be filled quickly at the stream or pond (Figure 1) and emptied direct into the spraying machine tanks by simply reversing the two pipes. This brings up a point in connection with the construction of many farm water carts that is inconvenient and time wasting during spraying ; the outflow pipe is so low that to empty the cart into barrels or containers standing by the spraying machine, it is necessary to sink these containers into the ground where the usual spray tackle is in use. Every time the machine is used, all containers have to be sunk afresh, wasting considerable time. Similarly, it is impossible in the ordinary way to empty the water carts direct into the tank on the spraying machine. It is difficult to see how the water cart can be improved without raising the centre of gravity unduly ; but the use of the large bore semi-rotary pump on the cart gets over the difficulty to some extent at least.

The mixing of spray fluid at Long Ashton is nearly all done centrally at the buildings. In the case of winter spraying, the correct amount of concentrated tar distillate wash is poured direct into the water cart, and the force of water passing through the two-inch treacle tap into the water cart is sufficient to produce a splendid mix.

Under certain circumstances, it is advantageous to mix in the tanks on the scaffold and for this purpose the tanks are marked inside at every 25 gallon point so that correct amounts of mixture can be easily made.

Where knapsacks are being used in the vicinity of the pond and the quantity of water used barely justifies carting, the water is bucketed out from the pond into wooden barrels, and mixing is done on the spot. In this case a very simple wooden device (Plate 2) is used for mixing the material thoroughly. The plate shows its construction, which can easily be carried out at home. It is used

with an up and down motion in the tub of liquid by forcing it, with the circular plate flat on the surface of the liquid at first to the bottom and then pulling up and so on. Two or three movements will obtain a much more thorough mixing than the usual rotary stirring with a stick or old besom.

The spraying tackle used on the farm falls into three groups: knapsack sprayers, a so-called "Headland Sprayer" and a petrol-driven Power Sprayer. The merit of knapsacks lies in the fact that they are very economical, no spray fluid going to waste in pipe lines and so on, and that no damage is caused by moving pipes about on a ground crop. At Long Ashton, they are used for spraying very young trees which require little liquid per acre, in closely planted young nursery rows and so on. The type of knapsack now in use on the farm seems to be an advance on the older types of knapsack usually seen. The pump for liquid and pressure is a separate unit from the knapsack itself (Plate 3). Far less trouble with knapsack blockages, etc., have been experienced with this outfit than when using the older pneumatic knapsacks of the same make, and users also find the construction of the knapsack more comfortable. In passing, it may be mentioned that, where rubber valve balls are used in knapsacks or other spraying tackle, when using a tar distillate wash, it is of the utmost importance to remove and wash them thoroughly every night, which takes little time and saves much delay.

The headland sprayer is of the usual type and will give about 90 lbs. pressure on two lances. In carrying out the winter spraying for which figures are given, this was not used. In general its main use is for spraying older nurseries and odd pieces that are too big to spray with knapsacks, or too awkward or steep to manage conveniently with the power sprayer. It is also used to supplement the power machine when it is essential to get a large area done in a short time.

The power machine (Plate 4) is mounted on a three-wheel base, the front wheel having a very large lock, thus making it easy to turn the whole outfit almost in its own length. There are two separate tanks of known capacity, so that mixing can be carried out if needed on the machine. In addition to the main power pumping unit, a supplementary rotary pump is fitted to the side of the outfit. This is of the utmost value in keeping up continuous work, as refilling from supplementary tubs or water carts can be carried out rapidly while spraying is in progress. The value of this is especially noticeable when using four nozzles with a coarse spray. A point which seems so obvious as to be unnecessary to mention, but which is nevertheless often overlooked, is decarbonising

the power unit. Unless this is done regularly good results cannot be expected from it.

For practically all winter work with this machine, a lay out of metal mains from the machine, standing on the headland, into the plantation with about 50ft. rubber hose extensions is used: this avoids moving the machine much and does not cut the ground up badly. Another method which will be described when dealing with summer spraying is used for certain types of plantation when the ground is firm. Briefly, it consists of drawing the spraying machine through the rows and using much shorter lengths of hose, the whole outfit being kept in continuous motion.

When using metal mains the following practice is employed and is found to save considerable time as well as keeping the engine attendant usefully employed.

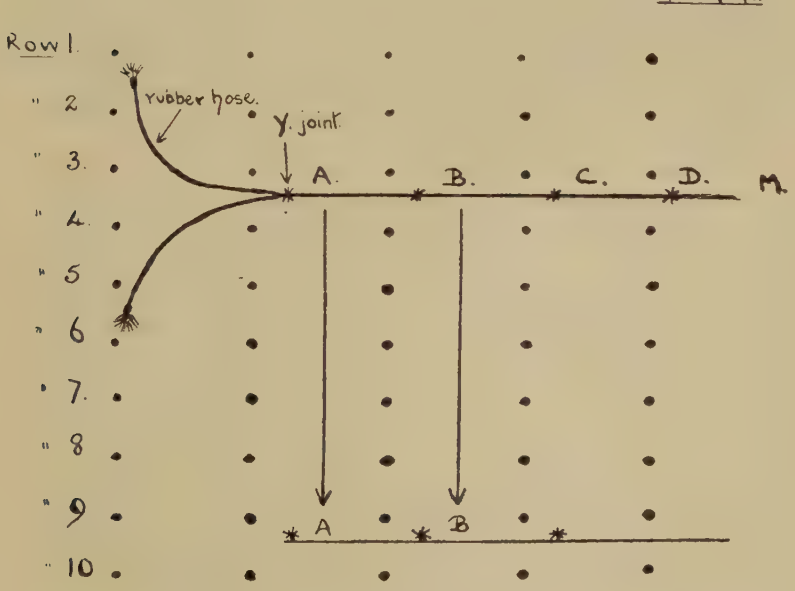

FIGURE II.

Assuming that it is possible to spray three rows on either side of the metal main with the length of rubber hose available, the mains are laid out between the third and fourth row from one side of the plantation (Figure 2). The mains do not screw directly into one another but are connected by short rubber joints with threaded metal

screw joints ; this makes the whole thing more pliable on rough land ; the thread of each jointing is made to fit both the metal main and the larger end of a Y joint for taking two lengths of hose. The length of rubber hose is such that, from the end connection on main A, all trees as far back as those reachable from main C can be sprayed. As soon as this is done mains A and B are disconnected, leaving the rubber connection on main C to which the rubber hoses are at once fixed with the Y piece and spraying recommenced. The engine attendant then moves mains A and B as opportunity affords along to a corresponding position six rows further on between rows 9 and 10. Similarly further lengths of main are moved into their new position and connected so that very little time is lost when the engine is moved to a new position. Cases have been seen where complete double sets of metal mains are in use on a farm with one engine, but this seems uneconomic where the above method can be employed. In any case, for tar distillate spraying, it seems advantageous to use as much metal main as possible and as little rubber hose as is compatible with reasonably quick work, as the latter material seems to suffer very serious depreciation with these washes. In all cases where possible, rubber pipes should be washed out with hot water or better still with steam under pressure at the end of a season's tar distillate spraying.

The question of the actual form and type of spray projector used seems likely to prove a topic of controversy. At Long Ashton "Meyers'" spray guns are almost always used with the power tackle unless very small and scattered trees are being sprayed when the common nozzle is used on a lance. (Such trees are usually knapsacked sprayed.) A pressure of not less than 160 lbs. per square inch is maintained on the pressure gauge for two guns and not less than 180 lbs. for four guns. The pressure in either case is pushed up beyond these points as far as possible without incurring undue risk of blow outs and bursts ; with the tackle available it is seldom possible to exceed 240 lbs. without trouble occurring. It might be mentioned at this point that there seem to be considerable openings for technical engineering improvements to spraying tackle in such matters as methods of connecting rubber hose. Guns are admittedly extravagant in the use of spray fluid, which is a serious matter when winter spraying, but they are not tiring to use, high and low trees can be reached equally easily and the speed of spraying a tree thoroughly is greater with guns than with an old-fashioned nozzle, provided pressure can be constantly maintained at an absolute minimum of 150 lbs. The question of speed of thorough spraying is one which seems all too often to be left out of account in any theoretical discussion of spraying. In the writer's opinion the practical problem seems to be one of getting a thorough cover

to the tree in most forms of spraying and getting it quickly. Whether it be winter or spring spraying to be done, our fickle climate allows of no time for finesse, and when weather conditions are favourable it is of the utmost importance to get the largest possible area thoroughly sprayed in the shortest time. To attain this end with the materials available, such things as " the fine misty spray," etc., cannot be adhered to completely, and the two alternative types of jet left are medium drenching spray and a coarse drenching spray. One further point exists in favour of the gun, which is that, with the fairly big jet of spray thrown, very little of the tree is ever missed.

Details of Winter Washing 1928-29.

The weather conditions during the whole period of winter spraying 1928-29 were abnormally good in comparison with the three preceding winters. The chances of running into wet weather seemed great on account of the abnormally good weather prevalent during nearly all the early part of the winter. For this reason spraying was made the first call on labour whenever the weather was fit from mid-December until the whole of the winter spraying was complete. Actually many more possible days would have been available, but it is seldom safe during a fine winter day to rely on a similar day to follow. In passing, it may be mentioned that it is impossible on most farms of any size to expect, in most seasons, to accomplish all necessary spraying on " the fine still days " so frequently recommended. Wind velocity will naturally make a very great difference to the amount of spray liquid needed. Fortunately it was possible to complete all spraying during relatively still weather ; the wind velocity during the spraying period is given in Table I, and it will be seen that for a large proportion of the time it ranged from calm to 12 M.P.H. During most of the period there were night frosts of varying intensity, which necessitated starting spraying relatively late in the day, often at 10 a.m., and stopping early to drain all pipes and take the engine indoors ; such relatively short spraying hours naturally increased the total cost of spraying above what it would have been in mild open weather. On one or two occasions an unexpected frost occurred overnight when the pipes had been left out undrained and considerable time was needed to thaw out and begin again next day. Cost of time lost due to this freezing up is included but is shown separately in the tables of costs ; its inclusion is justified on the ground that similar loss of time might normally have occurred on a large number of farms during the period under consideration.

Although there were a number of days during the period when

there was rain, the quantity was generally almost negligible, and only on December 27th and 31st, when it started about midday, did it cause spraying to be abandoned and ruin the work already done that day. This contingency again will necessarily occur on all fruit farms. The cost of spraying twice on the trees affected is taken as the cost of spraying ; a note of the circumstances is made in the tables, and an estimate of difference is given.

In Table I the dates of spraying each plot, together with some particulars of weather at the time, and a summary of the trees on the plot are given.

PLATE 1.

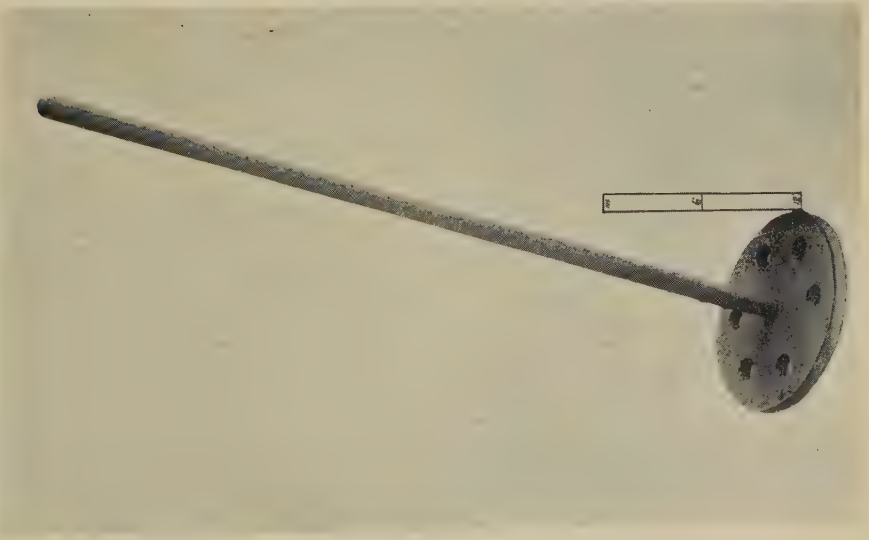

PLATE 2.

PLATE 3.

PLATE 4.

TABLE I.

Plot No.	Dates of spraying.	Wind.	Rain.	Frost. ° below 32°F.		Particulars of trees.
4*a*	13.12.28	12-18 M.P.H.	Nil			1,634 young black currants, pruned—due for 1st crop 1929. 1 acre.
	17.12.28	5-10 M.P.H.	Nil			
	18.12.28	Calm.	Nil			
6	5.1.29	12-20 M.P.H.	Nil			About 1,100 8-year gooseberries, thinned slightly. 2/3 acres approx.
	11.1.29	15-30 M.P.H.	Nil			
	14.1.29	10 M.P.H.	Nil		5°	
	15.1.29	10-20 M.P.H.	Nil		4°	
	16.1.29	8 to Calm	Nil			
15*a* & 16	19.12.28	10 M.P.H.	Nil		4°	500 3-year bush apples planted 15 x 15ft.
	20.12.28	Ditto	Nil		Nil	
17*a*	21.12.28	Calm	Nil		13°	682 black currants, pruned and very small. Due for first crop 1929.
	17.2.29	5-15 M.P.H.	Nil		3°	Standard apples 3 and 4 years old, just planted out at 36 x 36ft.
21	8.2.29	5-15 M.P.H.	Nil		4°	
1	4.2.29	Calm	Nil		6°	120 standard apples from 18-20 years old in grass, planted at 30 x 30ft.
	5.2.29	Calm	Nil		7°	
2	13.12.28	12-18 M.P.H.	Nil	14.12.28	11°	128 ½-standard plums, av. 12ft. spread, 11ft. height approx. Planted 15ft. x 30ft. ½ alleys intercropped with sundry soft fruit. Area 2½ acres approx.
7*a*	31.1.29	10-12 M.P.H.	.57″			Nursery—mostly 3-year feathered standard apples. 1,417 trees. planted 2 x 2½ft.
7*b*	2.1.29	12-20 M.P.H. } gusty	Nil			288 bush apples and 12 damsons—1¾ acres. 10-year trees planted 15 x 15 ft. Apples average height about 10ft. spread about 8ft., unpruned when unsprayed.
	3.1.29	Ditto } gusty	Nil		5°	
	4.1.29	Ditto } gusty	Nil		4°	
7*c*	19.12.28	10 M.P.H.			4°	431 bush apples (planted 15 x 15ft.), 15 standard Blaisdon plums. Height and spread of apples vary about 17ft. x 16ft. to 7½ft. x 5½ft.; a representative average of all being about 9ft. x 8½ft. Blaisdon plums average about 16ft. high, 10ft. spread. Pruning not done by spraying time. 2⅜ acres.
	20.12.28	Ditto				
	27.12.28	Ditto	.85″		4°	
	1.1.29	Ditto			8°	
	2.1.29	12-20 M.P.H. (gusty)				
8*a*	15.1.29	10-20 M.P.H.	Nil		4°	363 bush apples planted 15 x 15ft., average height 10ft., spread 11ft. (approx.). Pruning, consists of thinning only; complete. One-half the trees very dense (Allington). Remainder fairly open. (Edward VII)
	16.1.29	8 M.P.H. to Calm				
	17.1.29	Calm	.06″		17°	
10	17.12.28	5-10 M.P.H.	Nil			213 ½-standard plum trees of approx. average height, 11ft., spread 13ft. 1½ acres.
	18.12.28	Calm	Nil		9°	
	19.12.28	10 M.P.H.	Nil		4°	
11 & 11*a*	21.1.29	Calm	Nil		9°	340 bush apples 6 years. 374 bush pears 6 years.
20	26.1.29	10 M.P.H.	Nil		13°	Nursery of standard trees mainly just headed at about 6ft.
				27.1.29	18°	4,855 trees planted 4ft. x 2.3ft. About 1 acre. Very awkward shape.
	28.1.29	Calm—5 M.P.H.			11°	

TABLE III.

Plot No. and machine used.	Spraying hours.	Total labour cost.	Gallons used.	% Tar distillate concentrate.	Cost of conc. at 2/3 p.g.	Fuel.	Total cost nearest 1d.	Cost per acre approx.	Cost per tree approx.	Labour cost per acre approx.	Cost of labour per 100 galls. approx.
		£ s. d.			£ s. d.		£ s. d.	£ s. d.		£ s. d.	£ s. d.
Knapsacks 4*a*	17¼	17/3+3/11¼ £1 1 3	74	7½	12 10	—	1 14 1	1 14 1	about ¼d. per bush	17/3(without wasted time)	1 3 4
„ 6	44	2 5 0	258	5	1 9 0	—	3 14 0	5 11 0	under 1¼d per bush	3 7 6	17 4
„ 15*a* & 16	14½	16 10½	78	7½	13 6	—	1 10 5	12 0	$\frac{3}{5}$d. per tree	6 6	1 3 0
„ 17*a*	6¼	7 3½	36	7½	5 10	—	13 2	—	about ⅛d. per bush	—	1 0 4
„ 21	22½	1 5 1½	126	7½	1 1 3	—	2 6 5	—	—	—	1 0 0
„ Hillside	22	1 4 0	120	7½	1 0 3	—	2 4 3	—	—	—	1 0 0
Power 1	12	1 4 6¾ 21/9+9/11	700	7½	5 18 1½	9d.	7 3 6	3 5 4	1/3	11 0	3 6
„ 2	14	1 11 8	950	7½	7 19 9	1/6	9 12 11	3 17 3	—	8 9	3 4
„ 7*a*	1* 1/1½*		50*	7½	8. 6	3d.	2 6 5	—	less than ½d. per tree	—	3 3
	2½ 6/6	7 7½	180 230	7½	1 10 6						3 2
„ 7*b*	21	3 13 1½	1150	10 12½	15 2 2	1/6	18 16 10	10 15 0	1/2	2 0 6	6 4
„ 7*c*	31	3 18 4 59/-+6/-	1200	10	15 0 0	2/6	19 0 10	7 3 0	10d.	1 8 6	6 3
„ 8*a*	14	3 5 0	750	5	4 4 5	9d.	7 10 2	4 5 6	3d.	1 13 9 (W.W.T.)	4 9
„ 10	15½	1 18 6	850	7½	7 3 6	1/3	9 3 3	6 1 0	9d.	1 5 8	4 6
„ 11 & 11*a*	12	1 13 0	400	5	2 5 0	6d.	3 18 6	1 4 0	about ¾d. per tree	10 2	8 3
„ 14 & 15	13	2 0 0	500	5	2 16 3	3d.	4 16 6	1 2 0	—	9 3	8 0
„ 20	11	1 7 2¼	460	7½	3 17 7½	1/-	5 5 10		about ¼d. per tree	1 7 2	5 10

*This spraying repeated owing to rain.

Table II is divided into two parts ; firstly, where the power machine was used ; secondly, where knapsacks were used. Reference to the plan will indicate the length of water haulage needed for any one plot (see column 1). The Hillside piece lies to the south of Plot 7, and is for the most part very steep, rising towards the south. Plot 21 lies off the plan to the north, and is supplied with water from a pond rather towards one corner.

Column 2 shows the number of nozzle hours worked. This figure includes time lost on small breakdowns, nozzle blockages, and so on ; but does not include any major stoppages.

Column 3 shows the total cost of labour. No specific allowance has been made for overhead and supervisory costs, but the labour has been charged throughout at 9d. per man hour ; this is a higher figure than is earned by most of the men on the job, but it is estimated that this addition fully covers overheads and depreciation for the period. In certain cases such as Plots 2, 4A and 8A the total labour cost is given separately for actual spraying time cost (viz., Plot 2, 21 9) and time used due to freezing up or major breakdown (viz., Plot 2, 9 11, caused by 14° unexpected frost on December 14th). Actually in the period no major breakdown occurred ; frosts were the only serious causes of delay.

Columns 4, 5 and 6 give the total quantity of wash used, the percentage of concentrated tar oil used in the wash and the cost of the concentrate respectively. The quantity of wash used is discussed later. The percentage of concentrate is generally 5% or 7½% ; in the cases where 10% and 12½% were used this was done for special experimental purposes. The cost of the concentrate is taken at 2/3 per gallon ; this price again is put at a high figure for bulk purchases, but it is approximately the price of most proprietary tar oils.

The seventh column gives the cost of engine fuel and lubricant approximately : this figure is difficult to check satisfactorily, but, being so small, it makes very little difference to column 8—the total cost.

The remaining columns, 9—12, analyse the total cost to some extent ; to go into greater detail might cause confusion by the very multitude of the figures.

The most satisfactory way of examining the figures seems to be to consider them in detail on a few plots, and this is done below.

Plot 1.

Standard cider apples (sprayed experimentally), but for the present purpose might be considered as culinary or dessert varieties,

when a total cost of 1/3 per tree would seem very low. This may be accounted for to some extent by the fact that high pressure main water was available close at hand, and being a grass orchard the "going" was good all the time, there being no slipping about or heavy muddy pipes to move over rough plough ground. In addition to this the weather was calm.

Plot 2.

Due to the very mixed nature of the undercrops no detailed examination of figures seems valuable. The low labour cost per acre is accounted for by the fact that no haulage of water was needed.

Plots 7*a and* 20.

In both cases these are nurseries consisting largely of young 6ft. standards with feather. A considerable amount of pipe moving is needed in these nursery rows, but the cost at slightly over ¼d. per tree seems well justified.

Plots 7*b*, 7*c and* 8*a*.

The trees are representative of many lots of trees about 9 years old. A factor in the high cost on 7*b* and 7*c* is the high percentage of tar oil used, but in addition to this the wind was very gusty on 7*b*, ranging from 12-20 M.P.H.; this involved considerable loss in spraying one-third of the plot planted with Bramleys. In addition on Plot 7*c*, rain on December 27th added to the cost, involving re-spraying a few of the trees (quantities were unfortunately not recorded), and gusty wind on January 2nd involved further loss. On Plot 8*a* one more gun than usual was in use, and this seems definitely to have helped to reduce labour costs; in addition there was very little wind indeed on two of the spraying days.

Plot 10.

A very ordinary type of mixed plum orchard costing 9d. per tree indicates the economic value of this type of spraying for such an orchard, being probably the one spraying needed in the year.

Plots 11 *and* 11*a*.

Showing a cost of about ¾d. per tree on young trees involving considerable moving time as compared with actual time in which spray is leaving the gun again indicates the economic value of the operation.

Plots 14 *and* 15.

It is interesting to note that, on an acreage basis, these plots cost less than 11 and 11*a*; these are three-year apples intercropped

with black currants and, although 100 gallons more liquid at the same concentration was used, and there was rather more wind, the cost is slightly less. This is accounted for by the fact that all spraying could be done with the engine on the metalled road and no time was lost in moving from plant to plant.

The remainder of the plots for which figures are given were knapsack sprayed, and the only point of detail worth calling attention to is the fact that wind conditions were unfavourable, on Plot 6 on one day rising to 30 M.P.H. for a considerable time. This plot is also far from water. The main feature of interest in comparing "Knapsack" figures with "Power" figures is the relatively high cost of application per 100 gallons of spray from the former. This runs at from 17 4—23 4 for knapsacks to 3 4—8 3 for power per 100 gallons. This seems to indicate that where any appreciable quantity of spraying has to be done a good power machine not only gives greater pressure and speed of application, but in addition the actual cost of application per unit quantity of spray is appreciably less, thus justifying very much heavier capital outlay.

In the case of the plots sprayed at 10% concentration or over, had this strength been 5% the cost per acre would have been approximately £6 11s., on 7*b* about 8½d. per tree, and on Plot 7*c* slightly over 6d. per tree.

It is universally agreed that spraying operations are valuable, but this does not mean that in every case the expense is justified economically. The expenditure of spraying is in the nature of an insurance premium against the risk of disease. The likelihood of an attack of any disease and the extent of the damage which will probably result in the event of such an attack must be considered in estimating the risk and in deciding whether or not the premium is too high to be worth while.

In the case of an orchard of standard cider varieties such as Plot 1 the risk of disease is not so great as in some other cases and the financial loss in the event of an attack is not so heavy that an expenditure of 1/3 per tree might be considered justified.

On the other hand, the risk of aphis on plums is always great, and the loss in the event of an attack is not confined to one season, so that the expenditure of 9d. per tree on Plot 10 in spraying costs is probably a very much cheaper method of insurance than taking out a policy with an Underwriter at Lloyds.

REPORT ON BUNT PREVENTION TRIALS 1928.

By R. W. Marsh.

As in the previous year (Annual Report Long Ashton, 1927, p. 104), the Advisory Mycologist undertook the carrying out of Bunt Prevention Trials at the request of the Ministry of Agriculture. After the departure of Dr. Nattrass, the trial was completed by the writer. For the 1928 experiment, Long Ashton was the only centre chosen, and a double series of plots was laid down at the Research Station. The land used carried a crop of oats in 1926 and had subsequently been fallowed with frequent cultivations.

The plots were sown on the furrow soon after ploughing, by Dr. Nattrass and the writer, using seed of the variety Little Joss. This seed had previously been artificially contaminated with bunt spores and then treated with various fungicides. (This process was carried out at Cambridge by a small committee consisting of Messrs. W. Buddin, W. C. Moore and W. A. R. Dillon-Weston.) Details of the treatments for the various plots are as follows :—

Plots 1 and 8—Infected seed treated with 2.5 per cent. copper sulphate solution.

Plots 2 and 7—Infected seed untreated. (Control plots).

Plots 3 and 6—Infected seed treated with 2 ozs. copper carbonate powder per bushel.

Plots 4 and 5—Infected seed treated with 1 in 320 formalin solution.

Each plot consisted of eight drills 25 feet long, sown at the rate of 1 oz. of seed for each drill.

Plots 5 to 8 were sown on October 25, plots 1 to 4 on October 28. As soon as the seedlings of the first-sown plots appeared, bird depredations began, so the plots were entirely covered with strawberry netting from early November until February 6th. Growth was handicapped by heavy rains in November, frost and snow in the following month, and a cold spring. Plot 8, in particular, became partially waterlogged, and never fully recovered. Rapid growth took place in May and June and the final crop was denser than in ordinary farm practice, but the density was not obviously affected by the different treatments. Bunt was first observed in the control plots during the second week of July, and the heavy infection of these plots soon became apparent.

At the beginning of August the general condition of all the plots had again become poor. The plants showed a brownish-purple colour, they were moderately attacked by *Puccinia glumarum* and heavily infected with *Cladosporium herbarum*. These fungi occurred generally throughout the series of plots.

Records were taken on August 10 and 11, and are as follows :—

Plot.	Treatment.	Total Heads.	Bunted Heads.	Per cent. Bunted Heads.
1	Copper Sulphate ..	3855	1	.03
2	Control	3924	1060	27.01
3	Copper Carbonate ..	3933	4	.10
4	Formalin..	3862	(accidentally c	ontaminated)
5	Formalin..	3416	5	.15
6	Copper Carbonate ..	3746	0	—
7	Control	4322	1022	23.65
8	Copper sulphate.. ..	3363	0	—

The results of the trials corroborate those of previous years, showing that any of these dressings controls bunt without reducing the total yield, but no one of them shows, in this Province, any superior effectiveness.

CIDER-MAKING TRIALS FOR THE SEASON 1927-1928.

By O. Grove.

The cider apple crop of 1927 as a whole was above the average ; this was especially the case in Somerset and Devon, but in Hereford it was much lighter. As anticipated after the cold and wet summer, the specific gravities of the juices were low, the average for 180 samples being 1.0465, which is nearly seven points below the average specific gravity of the previous season's juices. As a specific gravity of 1.0465 corresponds to 11.5% of solids and the previous season's average gravity of 1.0532 represents 13.1% solids, it will be seen that the difference in solids for the two years is considerable. The difference is almost entirely in the sugar content. In spite of this low sugar content of the freshly expressed juices of 1927 the ciders produced during the season were of fair quality and generally better than could be expected.

The Cider Competitions.

For the third year in succession a competition was held on the lines described in the Annual Reports for 1926 and 1927. 180 entries of fruit were received. In each case 15 cwts. of fruit were used, the fruit kept until judged to be fit for milling, and the subsequent treatment the same in each case. The ciders were filtered when the juice had fermented down to the following specific gravities : Class I, 1.028 ; Classes II and VI, 1.030 ; and Classes III, IV and V, 1.025. Details of the entries will be found in Table 1 below.

The competition was open to growers residing in the counties of Devon, Dorset, Gloucester, Hereford, Monmouth, Somerset and Worcester. The entries from the different counties were distributed as follows :—Somerset 63, Devon 37, Gloucester 33, Worcester 19, Monmouth 13, Hereford 10, and Dorset 5.

The ciders were judged on April 19th and 20th, 1928, by Messrs. John W. Pullin, Compton Greenfield, Gloucester ; R. L. Roach, Crediton, Devon ; and S. Weston, Much Marcle, Hereford. Their report, the details of the Competition ciders and the list of awards are appended.

Amongst the entries there were several varieties not tried previously for cider-making at Long Ashton.

In *Class II* No. 22, Caswick, showed a very rapid rate of fermentation, and the cider was not of much value. No. 28, Shrawley Sweet, also fermented too rapidly and the cider was thin and without much character. No. 29, Stoke Red, which won the First Prize a year previously, when it was tried for the first time, was awarded Second Prize this season. This apple is undoubtedly an outstanding sharp variety. No. 30, Gloucester Pippin, had a very high content of malic acid and fermented too rapidly ; the cider was rather thin and sharp. No. 31 also showed a high rate of fermentation and gave a cider without much merit. No. 35 produced a rather inferior cider with an exceptionally high acidity. No. 36, Sour Natural, gave a very acceptable sharp cider. No. 37, White Spice, and No. 41, Cornish Aromatic, were similar in general character, but not very good ciders. No. 43, Red Dick, showed a very desirable slow rate of fermentation and produced a very fair sharp cider. Nos. 46, 47 and 48 were all sent in from Upton-on-Severn. The first, Clinch apple, gave a very good, sharp cider with good body ; the two others were inferior to No. 46. No. 52, Howard's Sharp, gave a very fair, sharp cider, useful for blending. Of the rest of the varieties in Class II, Nos. 55, 56, 57, 59 and 61 were not of great merit. No. 58, Woolston Spice gave a sharp cider of high quality and the same was the case in a lesser degree with No. 60, Hartisman.

In the *Sweet Class* (Class III) No. 62, Sweet Harcombe, was tried for the first time ; it gave a sweet cider of very good quality. No. 68, White Sweet, was a fair cider with moderate aroma and flavour, and the two Best Bearers, Nos. 71 and 76, were quite fair sweet ciders. No. 79, sent in under the name of Tom Putt, was not identical with this variety and certainly wrongly named ; the cider was quite pleasant, but lacked body. The rest of the varieties in this class have all been tested on former occasions.

In *Class IV* No. 85, Sam Tannin, produced a bitter-sweet cider with a moderately good, rather pronounced bitter flavour. Nos. 89 and 90, Spotted Dick, were quite useful ciders, somewhat lacking in body. No. 91 was similar in character and the same may be said of Nos. 95 and 96. No. 101, Sugar Pippin, which was awarded First Prize, was a cider of high merit with a very slow rate of fermentation. This apple may prove a very useful addition to the bittersweet group of cider apples. Nos. 102, 103 and 104 were moderately good ciders. No. 105 yielded a cider of good quality. The rest of the varieties in this class have been tested in earlier trials.

Class V, Mixed Varieties, showed a number of good ciders, in which the apples were blended in about the right proportions

Many of the entries were, however, too acid in flavour, 0.60% of malic acid and more being present in a number of cases ; one cider, in fact, contained as much as 0.95% of malic acid. When comparing the analyses of the four samples selected by the judges as the best of the 48 ciders, it will be seen that the acid and tannin figures are very similar. The figures are :—No. 138, 0.42% and 0.18% ; No. 121, 0.41% and 0.18% ; No. 164, 0.40% and 0.18% ; No. 140, 0.40% and 0.20%. For a cider filtered at a specific gravity of 1.025 these acid and tannin percentages give very good results, and about one-half of the entries would have been improved if the proportion of sharp apples used in the blends had been reduced. As a general rule a cider meant for use unblended and at the specific gravity mentioned should not contain more than 0.40% to 0.60% of malic acid, otherwise the acid character is too dominant. The First Prize winner, No. 138, was an excellent cider. The apples came from one of the Gloucester County Council's Trial Orchards planted about 20 years ago with trees supplied by the Research Station. Another prizewinner No. 140, was also made from apples from another of the Trial Orchards in Gloucestershire.

With regard to the *Perry Class* (Class VI), there were two newcomers ; No. 166, Eley's Nonsuch, which produced the best perry in the competition and possessed a very delicate flavour and good aroma and body, and No. 171, Coombe pear, which was quite fair, but not comparable in quality with the former.

Report of Judges on the Long Ashton Cider Competitions 1927-28.

The judging of the ciders in these competitions took place on Thursday, April 19th, and Friday, April 20th, to permit of the announcement of the awards on the occasion of the Annual Tasting Day on Thursday, May 3rd. It will be appreciated that the ciders at the time of the judging were still comparatively immature, but on the whole they were well forward in condition and could be satisfactorily compared.

The entries were divided into six classes, five for cider and one for perry. The five classes for cider were as in last year's competitions, viz. :—

	No. of Entries.
Class I. For the Kingston Black variety alone	21
„ II. „ single varieties of the Sharp class	40
„ III. „ „ „ „ Sweet „	22
„ IV. „ „ „ „ Bittersweet class	33
„ V. „ mixed varieties of apples, selected and blended by the individual competitors themselves in proportions judged by them to constitute a satisfactory blend ..	48
The Class for Perry, Class VI, was for any single variety of perry pear	16
Total	180

The Class I ciders, restricted to the Kingston Black variety only, were as a whole remarkably level in character and quality and of about normal acidity. While none were of exceptional merit, the class reached a good average standard for the variety and was thoroughly typical of it. The standard was certainly higher than anticipated after the unsatisfactory summer of 1927 and the consequent low original gravities of the juices. The colour, although not so deep as in some seasons, was adequate.

In Class II, that for " sharp " varieties, there was, as might be expected in so large a class, a considerable difference in standard between individual entries. All were remarkably clean on the palate and in nearly every case they would prove very useful for blending. The first and second prizewinners were of a particularly high degree of merit for the season and it was difficult to decide which should be given the premier award. Each of the others mentioned in the awards list can be considered as well above the normal standard for the season.

Class III for " sweet " varieties was a large one for this type of apple. The character and standard throughout were very even and distinctly useful for the season. The prizewinners were very clean, fairly soft and of good flavour. The colour generally was pale to medium for this class of cider. In this class and the following (Class IV) cider sickness had developed in a few samples. The appearance of this disorder at so early a date is noteworthy.

The bitter-sweet class (Class IV) was a large and good one. The degree of bitterness varied widely in individual samples, but the flavour was in nearly all cases clean and pleasant. On the whole the colour was much paler than usual for this class of cider.

Class V, that for blends of varieties, was one of variable merit. Few of the ciders showed any marked distinctive character, but many were of a very useful order and the first prizewinner was unusually good for the season. Generally the colour was on the pale side. Most of the entries were inclined to be on the sharp side, and the use of a smaller proportion of sharp apples in this particular season would probably have given better results.

In the class for Perry (Class VI) the entries generally were of a very level order of merit, being clean and of a very fair standard. While none were outstanding in quality, the average was higher than usual in a perry class. Had it not been for a rather excessive astringency in some cases, the standard would have been still higher.

We cannot conclude our Report without special reference to the manner in which so large a number of entries has been handled under conditions which have given all a fair chance. In not more than one or two instances has there been the least trace of any taint in flavour and in those cases it is evident that the state of the fruit on arrival at the Institute was responsible. There was in no case any sign of a taint acquired during the process of making. This we consider to be a very notable achievement under the conditions of the past cider-making season and the very large number of entries dealt with, and it reflects great credit upon those in charge of the cider-making operations.

It must also be a source of gratification to the Institute authorities that these Competitions have so quickly justified their establishment and aroused the wide degree of interest which the great increase in the number of entries demonstrates.

Signed JOHN W. PULLIN.
R. L. ROACH.
S. WESTON.
Judges.

Dated 25th April, 1928.

TABLE I.

COMPETITION VARIETIES.

No.	Name of Variety.	Date of making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of fermentation.	Date of Filtering.	Specific Gravity at time of Filtering.	Specific Gravity May, 1928.	Name and Address of Grower.
	CLASS 1.—Kingston Blacks—									
1	Kingston Black ..	31/10/27	1.050	0.70	0.17	3.2	3/1/28	1.028	1.027	H. A. Wadworth, Breinton Court, Her.
2	,, ,, ..	1/11/27	1.053	0.64	0.17	2.0	23/1/28	1.028	1.027	R. N. Scott, East Lambrook, Som.
3	,, ,, ..	1/11/27	1.058	0.67	0.18	3.0	16/2/28	1.028	1.028	E. W. Dabinett, Kingweston, Som.
4	,, ,, ..	1/11/27	1.052	0.69	0.16	2.4	3/1/28	1.028	1.028	D. P. Morgan, Bushley, Worc.
5	,, ,, ..	1/11/27	1.055	0.65	0.18	2.6	20/1/28	1.028	1.027	H. E. Dabinett, Somerton, Som.
6	,, ,, ..	1/11/27	1.053	0.63	0.16	2.8	20/1/28	1.028	1.028	F. J. Ludlow, Westbury-on-Trym, Glos.
7	,, ,, ..	2/11/27	1.050	0.60	0.16	2.0	27/1/28	1.028	1.028	G. Harden, Bridgwater, Som.
8	,, ,, ..	2/11/27	1.054	0.69	0.18	3.8	16/1/28	1.028	1.028	W. Wyatt, Kingweston, Som.
9	,, ,, ..	7/11/27	1.055	0.65	0.18	7.2	7/12/27	1.028	1.026	W. Maynard, Martock, Som.
10	,, ,, ..	7/11/27	1.053	0.60	0.19	3.2	13/2/28	1.028	1.028	H. C. Davis, Hewish, Som.
11	,, ,, ..	8/11/27	1.052	0.56	0.18	3.2	27/1/28	1.028	1.028	R. J. Denning, Ilminster, Som.
12	,, ,, ..	15/11/27	1.055	0.59	0.18	3.8	16/1/28	1.028	1.027	R. I. Wear, Congresbury, Som.
13	,, ,, ..	15/11/27	1.049	0.51	0.18	3.6	23/1/28	1.028	1.026	W. Hunt, Easton-in-Gordano, Som.
14	,, ,, ..	15/11/27	1.050	0.52	0.19	3.6	1/2/28	1.028	1.028	T. A. Powell, Ross, Her.
15	,, ,, ..	16/11/27	1.055	0.45	0.20	2.4	10 3/28	1.028	1.028	W. Hill, Kittisford, Som.
16	,, ,, ..	16/11/27	1.055	0.60	0.15	4.5	19/1/28	1.028	1.026	W. J. Houldey, Gorse Court, Glos.
17	,, ,, ..	16/11/27	1.055	0.62	0.18	3.6	20/1/28	1.028	1.027	G. H. Sawtell, Kingweston, Som.
18	,, ,, ..	16/11/27	1.055	0.57	0.17	3.3	7/2/28	1.028	1.028	G. W. Moody, Martock, Som.
19	,, ,, ..	16/11/27	1.055	0.58	0.18	3.2	16/2/28	1.028	1.028	H Knight, Huntley, Glos.
20	,, ,, ..	16/11/27	1.054	0.54	0.13	4.5	30/1/28	1.028	1.027	H. J. Phelps, Tibberton, Glos.
21	,, ,, ..	28/11/27	1.055	0.57	0.16	3.7	20/1/28	1.028	1.028	R. E. Turner, Dymock, Glos.
	CLASS 2.—Sharp Varieties—									
22	Caswick	18/10/27	1.042	0.93	0.10	7.0	29/10/27	1.030	1.015	W. Weaver, Shrawley, Worc.
23	Fair Maid ..	21/10/27	1.041	0.87	0.09	5.2	3/11/27	1.030	1.023	S. Cursons, Dunsford, Devon.
24	Wagstaff	25/10/27	1.048	0.82	0.09	4.6	4/11/27	1.030	1.030	P. E. Bomford, Upton Snodsbury, Worc.
25	Cap of Liberty ..	25/10/27	1.045	1.04	0.18	4.7	4/11/27	1.030	1.028	R. J. Denning, Ilminster, Som.
26	Crimson King ..	27/10/27	1.045	0.65	0.14	7.2	2/11/27	1.030	1.025	S. F. J. Clarke, Honiton, Devon.

TABLE I.—*continued.*

COMPETITION VARIETIES.

No.	Name of Variety.	Date of making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of fermentation.	Date of Filtering.	Specific Gravity at time of Filtering.	Specific Gravity May, 1928.	Name and Address of Grower.
	CLASS 2.—SHARP VARIETIES—*contd.*									
27	Fair Maid of Devon	27/10/27	1.039	0.85	0.14	5.7	1/11/27	1.030	1.027	W. E. Shapland, Tiverton, Devon.
28	Shrawley Sweet ..	27/10/27	1.041	0.73	0.14	4.5	3/11/27	1.030	1.028	W. Weavers, Shrawley, Worc.
29	Stoke Red	28/10/27	1.043	0.70	0.27	2.2	18/11/27	1.030	1.030	H. H. Sealy, Cheddar, Som.
30	Gloucester Pippin ..	28/10/27	1.045	1.03	0.14	5.2	4/11/27	1.030	1.027	E. Wood, The Hendre, Mon
31	Bittersweet	28/10/27	1.040	0.57	0.23	6.0	2/11/27	1.030	1.026	F. J. Ludlow, Westbury-on-Trym, Glos.
32	Fair Maid	28/10/27	1.042	0.93	0.11	4.6	5/11/27	1.030	1.030	H. G. New, Cullompton, Devon.
33	Fair Maid	31/10/27	1.044	0.83	0.12	4.7	8/11/27	1.030	1.029	H. H. Hames, Tiverton, Devon.
34	Bramley's Seedling	31/10/27	1.041	0.70	0.12	5.7	7/11/27	1.030	1.025	E. H. Wells, Wellington, Som.
35	Wilding	31/10/27	1.046	1.39	0.14	5.0	21/11/27	1.030	1.027	W. P. Merrett, Arlingham, Glos.
36	Sour Natural	1/11/27	1.042	0.59	0.14	2.2	6/12/27	1.030	1.030	J. Walters, Newton St. Cyres, Devon.
37	White Spice	1/11/27	1.042	0.76	0.11	2.6	29/11/27	1.030	1.029	W. Hunt, Easton-in-Gordano, Som.
38	Crimson King	2/11/27	1.045	0.56	0.13	4.7	19/11/27	1.030	1.026	J. H. Symes, Martock, Som.
39	Frederick	2/11/27	1.047	0.94	0.11	2.6	22/12/17	1.030	1.029	S. W. Mullins, Raglan, Mon.
40	Ponsford	2/11/27	1.044	0.73	0.09	4.0	1/12/27	1.030	1.028	H. Lee, Broadclyst, Devon.
41	Cornish Aromatic ..	4/11/27	1.044	0.51	0.11	4.5	21/11/27	1.030	1.029	H. G. New, Cullompton, Devon.
42	Frederick	7/11/27	1.047	0.90	0.12	5.0	2/12/27	1.030	1.029	G. Breakwell, Rockfield, Mon.
43	Red Dick	7/11/27	1.047	0.97	0.16	3.7	9/1/28	1.030	1.030	S. P. Taylor, Dymock, Glos.
44	Red Streak ..	7/11/27	1.052	0.94	0.20	6.2	9/12/27	1.030	1.029	W. Weavers, Shrawley, Worc.
45	Golden Ball ..	7/11/27	1.041	0.58	0.15	4.2	28/11/27	1.030	1.027	J. Bowditch, Stoke Abbott, Dorset.
46	Clinch Apple ..	8/11/27	1.048	0.64	0.20	5.0	30/11/27	1.030	1.028	Clinch & Goddard, Upton-on-Severn, Worc.
47	Severn Bank ..	8/11/27	1.039	0.62	0.09	7.0	26/11/27	1.030	1.017	,, ,, ,, ,,
48	Upton Sharp ..	8/11/27	1.040	0.99	0.13	5.5	28/11/27	1.030	1.024	,, ,, ,, ,,
49	Never Blight ..	9/11/27	1.046	0.60	0.20	3.8	24/12/27	1.030	1.029	S. H. Osborn, North Cadbury, Som.

CLASS 2.—SHARP VARIETIES—*contd.*

50	Never Blight ..	9/11/27	1.050	0.82	0.12	7.0	5/12/27	1.030	1.027	F. J. Ludlow, Westbury-on-Trym, Glos.
51	Crimson King ..	16/11/27	1.045	0.54	0.11	6.7	6/12/27	1.030	1.029	G. H. Chudley, Dainton, Devon.
52	Howards Sharp ..	17/11/27	1.042	0.87	0.23	4.0	3/12/27	1.030	1.029	E. A. Austin, Baltonsborough, Som.
53	Cap of Liberty ..	17/11/27	1.044	0.84	0.26	2.7	6/1/28	1.030	1.030	G. W. Moody, Martock, Som.
54	Cap of Liberty ..	17/11/27	1.048	0.81	0.28	3.0	21/1/28	1.030	1.030	W. Maynard, Martock, Som.
55	Maiden Blush ..	21/11/27	1.047	1.00	0.12	4.8	9/12/27	1.030	1.028	H. Knight, Huntley, Dorset.
56	Court Apple ..	22/11/27	1.041	0.98	0.15	6.4	5/12/27	1.030	1.022	F. J. Ludlow, Westbury-on-Trym, Glos.
57	Barn Door ..	22/11/27	1.048	0.85	0.32	7.0	5/12/27	1.030	1.025	W. Wyatt, Kingweston, Som.
58	Woolston Spice ..	22/11/27	1.041	0.61	0.13	4.2	9/12/27	1.030	1.029	S. H. Osborn, North Cadbury, Som.
59	Leather Head ..	22/11/27	1.045	0.86	0.22	3.6	22/12/27	1.030	1.029	G. Breakwell, Rockfield, Mon.
60	Hartisman	23/11/27	1.045	0.80	0.22	2.5	22/12/27	1.030	1.029	W. Hunt, Easton-in-Gordano, Som.
61	Maiden Blush ..	28/11/27	1.047	0.52	0.10	5.0	22/12/27	1.030	1.030	R. E. Turner, Dymock, Glos.

CLASS 3.—SWEET VARIETIES—

62	Sweet Harcombe ..	17/10/27	1.050	0.26	0.15	3.8	2/12/27	1.025	1.025	C. Harden, Bridgwater, Som.
63	IlminsterMorgan Sw.	20/10/27	1.056	0.29	0.12	5.2	18/11/27	1.025	1.024	R. J. Denning, Ilminster, Som.
64	Pound Apple ..	27/10/27	1.051	0.34	0.15	7.0	4/11/27	1.025	1.024	S. F. J. Clarke, Honiton, Devon.
65	Sweet Alford ..	28/10/27	1.045	0.28	0.15	2.1	21/1/28	1.025	1.025	S. Cursons, Dunsford, Devon.
66	Sweet Alford ..	31/10/27	1.049	0.32	0.16	6.0	17/1/28	1.025	1.024	G. H. Hames, Tiverton, Devon.
67	Eggleton Styre ..	31/10/27	1.044	0.35	0.12	4.6	12/11/27	1.025	1.022	F. Pole, Holmer, Her.
68	White Sweet ..	1/11/27	1.046	0.33	0.17	3.8	26/11/27	1.025	1.024	W. Wyatt, Kingweston, Som.
69	Perthyres	2/11/27	1.044	0.32	0.18	3.5	23/11/27	1.025	1.023	S. W. Mullins, Raglan, Mon.
70	Sweet Alford ..	2/11/27	1.046	0.25	0.12	2.5	27/1/12	1.025	1.025	H. Lee, Broadclyst, Devon.
71	Best Bearer ..	4/11/27	1.043	0.21	0.13	4.3	29/11/27	1.025	1.023	H. E. R. Warren, Netherbury, Dorset.
72	Perthyres	7/11/27	1.040	0.33	0.14	5.0	28/11/27	1.025	1.022	G. Breakwell, Rockfield, Mon.
73	Sugar Loaves ..	7/11/27	1.040	0.20	0.14	4.5	5/12/27	1.025	1.022	R. Huggins, Thorverton, Devon.
74	Sweet Alford ..	7/11/27	1.044	0.19	0.13	3.0	28/12/27	1.025	1.026	„ „ „
75	Sweet Alford ..	8/11/27	1.043	0.28	0.10	4.5	7/12/27	1.025	1.023	J. T. Shield, Berkeley, Glos.
76	Best Bearer ..	9/11/27	1.045	0.27	0.13	6.5	8/12/28	1.025	1.024	J. Bowditch, Stoke Abbott, Dorset.
77	Sweet Alford ..	15/11/27	1.047	0.16	0.13	3.6	14/1/28	1.025	1.024	S. B. Neill, Woodbury Salterton, Devon.
78	Northwoods ..	15/11/27	1.045	0.27	0.14	5.0	16/12/27	1.025	1.025	R. Huggins, Thorverton, Devon.
79	Tom Putt (?) ..	15/11/27	1.050	0.23	0.17	6.4	12/12/27	1.025	1.023	W. J. Boon, East Lydford, Som.
80	Sweet Alford ..	16/11/27	1.049	0.21	0.12	3.2	23/1/28	1.025	1.025	H. J. Phelps, Tibberton, Glos.
81	Sweet Alford ..	16/11/27	1.046	0.18	0.11	3.0	23/1/28	1.025	1.025	J. Walters, Newton St. Cyres, Devon.
82	Sweet Alford ..	21/11/27	1.048	0.26	0.11	2.6	20/1/28	1.025	1.024	W. J. Berry, Newton St. Cyres, Devon.
83	Woodbine	22/11/27	1.056	0.33	0.17	4.2	27/1/28	1.025	1.024	W. Hill, Kittisford, Som.

TABLE I.—*continued.*

COMPETITION VARIETIES.

No.	Name of Variety.	Date of making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of fermentation.	Date of Filtering.	Specific Gravity at time of Filtering.	Specific Gravity May, 1928.	Name and Address of Grower.
	CLASS 4.—Bittersweet Varieites—									
84	Royal George ..	17/10/27	1.047	0.23	0.21	4.1	7/11/27	1.025	1.025	W. Hunt, Easton-in-Gordano, Som.
85	Sam Tannin ..	18/10/27	1.052	0.32	0.26	7.0	2/11/27	1.025	1.023	H. H. Sealy, Cheddar, Som.
86	Hangdown	21/10/27	1.047	0.29	0.22	4.2	4/11/27	1.025	1.024	,, ,, ,, ,,
87	Cummy Norman ..	25/10/27	1.048	0.29	0.18	3.6	26/11/27	1.025	1.025	F. Hodges, Barton St. David, Som.
88	Broadleaf Norman	25/10/27	1.047	0.35	0.27	3.3	11/11/27	1.025	1.024	H. A. Wadworth, Breinton Court, Her.
89	Spotted Dick ..	27/10/27	1.048	0.25	0.24	5.7	27/11/27	1.025	1.019	S. F. J. Clarke, Honiton, Devon.
90	Spotted Dick ..	27/10/27	1.051	0.25	0.20	4.0	26/11/27	1.025	1.024	W. E. Shapland, Tiverton, Devon.
91	Improved Bittersw't	28/10/27	1.040	0.36	0.20	2.7	25/11/27	1.025	1.025	S. Cursons, Dunsford, Devon.
92	Loyal Drain ..	28/10/27	1.050	0.32	0.42	2.3	7/2/28	1.025	1.025	H. E. Dabinett, Somerton, Som.
93	Red Jersey ..	30/10/27	1.049	0.28	0.34	3.3	21/1/28	1.025	1.025	R. J. Denning, Ilminster, Som.
94	Chisel Jersey ..	30/10/27	1.049	0.40	0.28	3.0	16/1/28	1.025	1.025	G. H. Hames, Tiverton, Devon.
95	Newton Bitter ..	1/11/27	1.048	0.38	0.27	4.0	10/12/27	1.025	1.025	J. Walters, Newton St. Cyres, Devon.
96	Bittersweet.. ..	2/11/27	1.045	0.30	0.20	2.0	27/1/28	1.025	1.025	S. W. Mullins, Raglan, Mon.
97	Dove	2/11/27	1.043	0.28	0.28	2.0	4/1/28	1.025	1.025	W. Wyatt, Kingweston, Som.
98	Broadleaf Jersey	2/11/27	1.050	0.29	0.33	3.0	22/12/27	1.025	1.025	G. H. Sawtell, Kingweston, Som.
99	Royal Wilding ..	2/11/27	1.045	0.24	0.20	2.7	22/12/27	1.025	1.025	F. Pole, Homer, Her.
100	White Norman ..	7/11/27	1.050	0.26	0.27	3.5	8/2/28	1.025	1.025	W. R. Thomas, Nunnington, Her.
101	Sugar Pippin ..	7/11/27	1.045	0.22	0.20	4.0	23/1/28	1.025	1.025	S. P. Taylor, Dymock, Glos.
102	Bower Bittersweet	8/11/27	1.048	0.39	0.38	4.4	24/12/27	1.025	1.025	C. Harden, Bridgwater, Som.
103	Shrawley Bittersweet	9/11/27	1.048	0.36	0.40	5.2	17/12/27	1.025	1.024	W. Weavers, Shrawley, Worc.
104	Devonshire Bitters't	9/11/27	1.048	0.44	0.21	4.7	29/12/27	1.025	1.025	S. P. Taylor, Dymock, Glos.
105	Broom	15/11/27	1.046	0.22	0.20	4.0	10/1/28	1.025	1.024	D. Lewis, Raglan, Mon.
106	Prince Albert ..	15/11/27	1.047	0.23	0.25	7.4	3/12/27	1.025	1.021	N. J. Davis, Berkeley, Glos.
107	Royal Wilding ..	16/11/27	1.049	0.21	0.20	4.7	20/12/27	1.025	1.025	W. R. Thomas, Nunnington, Her.

CLASS 4.—BITTERSWEET VARIETIES—*contd.*

108	Jaysies	17/11/27	1.049	0.24	0.20	3.6	16/1/28	1.025	1.024	R. W. Wyatt, West Lambrook, Som.
109	Broadleaves ..	17/11/27	1.052	0.30	0.30	5.0	5/1/28	1.025	1.025	W. Maynard, Martock, Som.
110	Strawberry Norman	17/11/27	1.051	0.32	0.32	3.7	2/1/28	1.025	1.025	H. A. Lane, Chaceley, Worc.
111	Yarlington Mill ..	22/11/27	1.043	0.25	0.24	2.8	3/1/28	1.025	1.025	S. H. Osborn, North Cadbury, Som.
112	Chisel Jersey ..	22/11/27	1.052	0.29	0.41	3.6	17/1/28	1.025	1.025	„ „ „ „
113	Chisel Jersey ..	22/11/27	1.056	0.32	0.31	4.2	20/1/28	1.025	1.025	G. W. Moody, Martock, Som.
114	Harry Masters' Jersey	22/11/27	1.055	0.23	0.25	4.4	21/1/28	1.025	1.025	S. H. Osborn, North Cadbury, Som.
115	Dabinett	22/11/27	1.050	0.23	0.26	4.0	16/1/28	1.025	1.023	J. H. Symes, Martock, Som.
116	Red Jersey ..	23/11/27	1.050	0.23	0.36	1.7	13/2/28	1.025	1.025	E. A. Austin, Baltonsborough, Som.

CLASS 5.—MIXED VARIETIES—

117	Rodneys 3, Hangdown 4, Sam Tannin 3, Stoke's Red 5 ..	21/10/27	1.044	0.45	0.20	4.7	7/11/27	1.025	1.023	H. H. Sealy, Cheddar, Som.
118	Dymock Broadtail 8, Shrawley Sweet 7	21/10/27	1.043	0.67	0.13	5.7	2/11/27	1.025	1.023	W. Weavers, Shrawley, Worc.
119	Skyrmes Kernel 5, Red Soldier 5, White French 5 ..	21/10/27	1.043	0.70	0.10	7.0	31/10/27	1.025	1.020	D. P. Morgan, Bushley, Worc.
120	Hangdown 5, Woodbine 4, Ponsford 1, Fair Maid of Devon 3, Sweet Alford 2	26/10/27	1.047	0.44	0.15	3.2	24/11/27	1.025	1.025	S. Cursons, Dunsford, Devon.
121	Sweet Alford 4, Bitter Cluster 3, Sweet Coppin 3, Plum Tree Sour 5	26/10/27	1.048	0.41	0.18	3.5	16/11/27	1.025	1.025	J. W. Hussey, Cullompton, Devon.
122	Spotted Dick 3, Fair Maid 3, Improved Pound 3, Sweet Alford 3, Woodbine 3	27/10/27	1.047	0.37	0.15	6.0	5/11/27	1.025	1.024	S. F. J. Clarke, Honiton, Devon.
123	Stone's Bitter 4, Sweet Alford 4, Ponsford 4, Spotted Dick 3	27/10/27	1.045	0.34	0.17	5.2	7/11/27	1.025	1.022	W. E. Shapland, Tiverton, Devon.

TABLE I.—*continued.*

COMPETITION VARIETIES.

No.	Name of Variety.	Date of making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of fermentation.	Date of Filtering.	Specific Gravity at time of Filtering.	Specific Gravity May, 1928.	Name and Address of Grower.
CLASS 5.—MIXED VARIETIES—*contd.*										
124	Beckingham Brandy 8, Tom Tanner 3, Cadbury 4	28/10/27	1.044	0.62	0.18	6.3	3/11/27	1.025	1.024	J. Barrer, Compton Greenfield, Glos.
125	Horner 4, Sharpshaws 2, Badens 5, Dabinett 4 ..	28/10/27	1.051	0.53	0.29	4.7	18/11/27	1.025	1.024	G. E. Tyley, Cheddar, Som.
126	Dove 4, Horner 3, Local Fancy 4, Littleton Pippin 4	28/10/27	1.044	0.67	0.16	5.2	14/11/27	1.025	1.021	H. E. Dabinett, Somerton, Som.
127	Sweet Blenheim 3, Crimson King 3, Cadbury 3, Hangdown 3, George 3	28/10/27	1.048	0.55	0.20	3.5	2/11/27	1.025	1.025	S. J. Sheppey, Bradford, Som.
128	Cap of Liberty 3 Howard Sharp 3, Red Jersey 3, White Jersey 3, Horner 3	28/10/27	1.048	0.64	0.25	3.5	16/1/28	1.025	1.025	E. A. Austin, Baltonsborough, Som.
129	Merton's Bitter 4, Sweet Alford 6, Ponsford 5 ..	28/10/27	1.047	0.62	0.18	5.0	23/11/27	1.025	1.022	W. B. Johns, Huish Barton, Devon.
130	Strawberry Norman 5, Royal Wilding 5, Frederick 5 ..	28/10/27	1.049	0.72	0.22	4.2	28/11/27	1.025	1.024	E. Wood, The Hendre, Mon.
131	Killerton Sweet 5, Fair Maid 5, Sweet Coppin 5	31/10/27	1.045	0.40	0.10	5.0	23/11/27	1.025	1.023	H. Lee, Broadclyst, Devon.

CLASS 5.—MIXED VARIETIES—*contd.*

132 Cap of Liberty 4, Woodbine 4, Red Jersey 3, Ashwell Red 4	31/10/27	1.043	0.58	0.16	4.3	23/11/27	1.025	1.023	R. J. Denning, Ilminster, Som.
133 Sweet Alford 5, Abbeydales 5, Butter Box 2, Pocket Apple 1, Bittersweet 1, Teign Harvey 1	31/10/27	1.048	0.49	0.16	4.2	10/12/27	1.025	1.023	H. Smerdon, Dainton, Devon.
134 Sharp Apple 5, Dove 5, White Sweet 5..	1/11/27	1.044	0.49	0.22	4.4.	19/11/27	1.025	1.023	W. Wyatt, Kingweston, Som.
135 Berkeley Pippin 4, White George 4, Honeyhall Red 4, Sugar Apple 3 ..	2/11/27	1.046	0.54	0.12	2.7	12/12/27	1.025	1.023	R. I. Wear, Congresbury, Som.
136 Frederick 4, Perthyre 4, Iron Apple 4, Mullins' Kernel 3	7/11/27	1.046	0.58	0.15	4.5	19/12/27	1.025	1.025	S. W. Mullins, Raglan, Mon.
137 Severn Bank 7, Sweet 2, Bran Rose 6 ..	8/11/27	1.046	0.62	0.15	5.0	9/12/27	1.025	1.024	Clinch & Goddard, Upton-on-Severn, Worc.
138 Cherry Pearmain 2, Sweet Alford 3, Red Foxwhelp 3, Eggleton Styre 3, Knotted Kernel 2, Strawberry Norman 1, Cherry Norman 1 ..	8/11/27	1.047	0.42	0.18	4.6	12/12/27	1.025	1.025	J. P. Eley, Frampton Cotterell, Glos.
139 Jelly Apple 5, Pip George 5, Sour Apple 5	8/11/27	1.045	0.57	0.20	3.6	12/1/28	1.025	1.025	J. E. Atherton, Flax Bourton, Som.
140 Sweet Alford 5, Royal Jersey 4, Cap of Liberty 3, Eggleton Styre 3	8/11/27	1.048	0.40	0.20	4.6	28/12/27	1.025	1.025	J. T. Shield, Berkeley, Glos.

TABLE I.—*continued.*

COMPETITION VARIETIES.

No.	Name of Variety.	Date of making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of fermentation.	Date of Filtering.	Specific Gravity at time of Filtering.	Specific Gravity May, 1928.	Name and Address of Grower.
	CLASS 5.—MIXED VARIETIES—*contd.*									
141	Yellow Pippin 2, Old Sodbury 3, Cider Beauties 2, Green Russett 8 ..	8/11/27	1.044	0.76	0.14	5.5	2/12/27	1.025	1.023	F. J. Ludlow, Westbury-on-Trym, Glos.
142	Belle Norman 10, Frederick 5 ..	9/11/27	1.045	0.52	0.20	7.0	30/11/27	1.025	1.024	J. Griffiths, Werngifford, Mon.
143	Foxwhelp 7½, Sowings 7½ ..	9/11/27	1.042	0.58	0.25	5.0	1/12/27	1.025	1.024	P. E. Bomford, Upton Snodbury, Worc.
144	Derby Sweet 3, Bower Sharp 2, Bower Red 2, Bower Sweet 3, Late Morgan 3, Bower Branin 2 ..	9/11/27	1.049	0.55	0.17	6.2	12/12/27	1.025	1.023	C. Harden, Bridgwater, Som.
145	Never Blight 5, Hangdown 5, King Alford 5	9/11/27	1.044	0.45	0.17	5.0	9/12/27	1.025		W. J. Boon, East Lydford, Som.
146	Royal Wilding 7, Strawberry Norman 3, Dymock Red 2, Foxwhelp 2, Sheepsnout 1 ..	9/11/27	1.047	0.56	0.19	4.0	26/12/27	1.025	1.025	S. P. Taylor, Dymock, Glos.
147	Coccagee 1, Golden Ball 8, Best Bearer 2, Forsey's 2, Bitter Sweet 2	9/11/27	1.046	0.50	0.19	4.2	23/12/27	1.025	1.025	J. Bowditch (I) Stoke Abbott, Dorset.

CLASS 5.—MIXED VARIETIES—*contd.*

148	Little White 4, Bitter Sweet 4, Golden Ball 7	9/11/27	1.045	0.36	0.17	4.7	19/12/27	1.025	1.024	„ (II) „ „ „
149	Sweet Alford 5, Bitter Sweet 5, Spotted Dick 5 ..	15/11/27	1.046	0.23	0.17	4.4	19/12/27	1.025	1.024	S. B. Neill, Woodbury Salterton, Devon.
150	White Sweet 5, Chisel Jersey 5, Bastard Tom Putt 5	15/11/27	1.044	0.69	0.13	4.0	9/1/28	1.025	1.024	W. Hunt, Easton-in-Gordano, Som.
151	Foxwhelp 2, Knotted Kernel 6, Coleman's Seedling 7 ..	16/11/27	1.049	0.38	0.16	4.5	10/1/28	1.025	1.025	G. H. Hames, Tiverton, Devon.
152	Sweet Alford 1, Royal Jersey 2, Yarlington Mill 4, Lambrook Pippin 1, Woodbine 3, Doux Amer 2, Osborne's Cadbury 2.. ..	16/11/27	1.048	0.23	0.16	5.0	16/12/27	1.025	1.024	H. Hawkins, Brookthorpe, Glos.
153	Royal Jersey 5, Strawberry Norman 2, Sweet Alford 7, Medaille d'or 1 ..	16/11/27	1.047	0.21	0.22	3.2	14/1/28	1.025	1.025	G. H. Chudley, Dainton, Devon.
15	Perthyre 4, Broom 4, Frederick 7 ..	17/11/27	1.044	0.51	0.13	3.2	9/1/28	1.025	1.025	D. Lewis, Raglan, Mon.
15	Sweet Alford 8, Newton Bitter 2, Wyatt's Seedling 5	17/11/27	1.044	0.32	0.21	3.0	30/1/28	1.025	1.025	J. Walters, Newton St. Cyres, Devon.
156	Spout Apples 7½, Bullock's Abundance 7½ ..	17/11/27	1.046	0.95	0.15	5.0	23/12/27	1.025	1.023	G. E. Bubb, Westbury-on-Severn, Glos.

TABLE I.—*continued.*

COMPETITION VARIETIES.

No.	Name of Variety.	Date of making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of fermentation.	Date of Filtering.	Specific Gravity at time of Filtering.	Specific Gravity May, 1928.	Name and Address of Grower.
	CLASS 5.—MIXED VARIETIES—*contd.*									
157	Crimson King, 5, Cap of Liberty 4, Dabinett 4, Royal Jersey 2	17/11/27	1.048	0.54	0.20	3.7	16/1/28	1.025	1.024	J. H. Symes, Martock, Som.
158	Dorset 3, Hangdown 4, White Sour 4, Jersey 4	17/11/27	1.050	0.50	0.22	3.2	31/1/28	1.025	1.025	W. Maynard, Martock, Som.
159	Court de Wick 5, White Styre 1, Red Streak 2, Hangdown 2, Red Wilding 2, Underleaf 3	22 11/27	1.044	0.63	0.17	4.2	22/12 27	1.025	1.025	B. Pearce, Winford, Som.
160	White Norman 5, Red Streak 5, Golden Moyle 5 ..	22 11/27	1.045	0.55	0.17	6.0	12 12/27	1.025	1.023	H. Knight, Huntley, Glos.
161	Sweet Alford 8, Sour Natural 7 ..	23/11 27	1.045	0.38	0.18	1.7	6/1/28	1.025	1.025	W. J. Berry, Newton St. Cyres, Devon.
162	Cap of Liberty 1, Girdle Pippin 4, Bunch Jersey 3, Striped Norman 4, White Sweet 3 ..	28/11/27	1.048	0.45	0.17	5.0	14/1/28	1.025	1.025	G. H. Sawtell, Kingweston, Som.
163	Sugar Pippin 5, Styre 5, Bitter Sweet 5	28/11/27	1.050	0.60	0.16	5.8	26/12/27	1.025	1.025	R. E. Turner, Dymock, Glos.
164	Sheep's Nose 4, Red Bitter 3, Red Soldier 8 ..	6/12/27	1.043	0.40	0.18	4.6	17/12/27	1.025	1.023	G. W. Green, Colyford, Devon.

CLASS 6.—PERRIES—

165	Holyer Pear ..	18 10 27	1.052	0.67	0.10	4.8	7/11 27	1.030	1.029	F. Pole, Holmer, Her.
166	Eley's Nonsuch ..	20 10 27	1.044	0.41	0.09	3.0	21/11 27	1.030	1.030	J. P. Eley, Frampton Cotterell, Glos.
167	Blakeney Red ..	20 10 27	1.046	0.50	0.14	3.2	24/11 27	1.030	1.030	D. P. Morgan, Bushley, Worc.
168	Barland	25 10 27	1.043	0.60	0.10	6.3	31 10 27	1.030	1.026	W. Weavers, Shrawley, Worc.
169	Huff Cap	25 10 27	1.042	0.40	0.08	5.3	1 11 27	1.030	1.024	F. Pole, Holmer, Her.
170	Blakeney Red ..	25 10 27	1.039	0.42	0.07	2.7	5/11/27	1.030	1.030	H. Knight, Huntley, Glos.
171	Coombe Pear ..	31/10 27	1.042	0.37	0.09	4.0	14/11 27	1.030	1.027	F. J. Ludlow, Westbury-on-Trym, Glos.
172	Blakeney Red ..	1 11 27	1.040	0.51	0.09	2.3	21/11 27	1.030	1.027	S. W. Mullins, Raglan, Mon.
173	Butt Pear	1 11 27	1.048	0.58	0.25	2.3	1/2/28	1.030	1.030	D. P. Morgan, Bushley, Worc.
174	Red Longdon ..	4/11 27	1.039	0.47	0.13	2.7	21/11/27	1.030	1.022	H. Knight, Huntley, Glos.
175	Longdon	4/11/27	1.044	0.34	0.10	7.3	14/11/27	1.030	1.026	S. P. Taylor, Dymock, Glos.
176	Butt	4 11/27	1.046	0.47	0.16	2.7	16 12 27	1.030	1.027	Clinch & Goddard, Upton-on-Severn, Worc.
177	Notton Butt Pear ..	15/11 27	1.050	0.44	0.28	1.8	20/2/28	1.030	1.030	C. E. Bubb, Westbury-on-Severn, Glos.
178	Oldfield	17 11 27	1.054	0.58	0.20	2.6	13/2/28	1.030	1.030	J. N. Gwynne, Sutton, Her.
179	Rock Pear ..	22 11 27	1.068	0.43	0.46	2.6	11/4 28	1.030	1.028	W. J. Houldney, Corse Court, Glos.
180	Butt	23 11 27	1.050	0.55	0.28	3.7	7/2/28	1.030	1.030	H. A. Lane, Chaceley, Worc.

TABLE II.

Competition Ciders and Perries, 1927-28.

JUDGES' AWARDS.

Ciders.

Class 1.	*No.*	Kingston Black. (21 *Entries*).
First Prize ..	19	H. Knight, Huntley, Glos.
Second Prize ..	11	R. J. Denning, Ilminster, Som.
Third Prize ..	15	W. Hill, Kittisford, Som.
Fourth Prize ..	18	G. W. Moody, Martock, Som.
Reserve	10	H. C. Davis, Hewish, Som.
Highly Commended	7	C. Harden, Bridgwater, Som.
,, ,,	14	T. A. Powell, Ross, Hereford.
,, ,,	20	H. J. Phelps, Tibberton, Glos.

Class 2.		Sharp Varieties. (40 *Entries*).	*Name of Variety.*
First Prize ..	39	S. W. Mullins Raglan, Mon. ..	Frederick.
Second Prize ..	29	H. H. Sealy, Cheddar, Som. ..	Stoke Red.
Third Prize ..	58	S. H. Osborn, Nth. Cadbury, Som.	Woolston Spice.
Fourth Prize ..	46	Clinch & Goddard, Upton-on-Severn, Worcs.	Clinch's Apple.
Reserve	33	G. H. Hames, Tiverton, Devon ..	Fair Maid.
Highly Commended	36	J. Walters, Newton St. Cyres, Devon	Sour Natural.
,, ,,	50	F. J. Ludlow, Westbury-on-Trym, Glos.	Never Blight.
,, ,,	53	G. W. Moody, Martock, Som. ..	Cap of Liberty.
,, ,,	54	W. Maynard, Martock, Som. ..	Cap of Liberty.
,, ,,	60	W. Hunt, Easton-in-Gordano, Som.	Hartisman.

Class 3.		Sweet Varieties. (22 *Entries*)	
First Prize ..	70	H. Lee, Broadclyst, Devon ..	Sweet Alford.
Second Prize ..	81	J. Walters, Newton St. Cyres, Devon	Sweet Alford.
Third Prize ..	75	J. T. Shield, Berkeley, Glos. ..	Sweet Alford.
Fourth Prize ..	63	R. J. Denning, Ilminster, Som. ..	Ilminster Morgan Sweet.
Reserve	77	S. B. Neill, Woodbury Salterton, Devon	Sweet Alford.
Highly Commended	62	C. Harden, Bridgwater, Som. ..	Sweet Harcombe.
,, ,,	74	R. Huggins, Thorverton, Devon	Sweet Alford.
,, ,,	80	H. J. Phelps, Tibberton, Glos. ..	Sweet Alford.

Class 4.		Bittersweet Varieties. (33 *Entries*).	
First Prize ..	101	S. P. Taylor, Dymock, Glos. ..	Sugar Pippin.
Second Prize ..	99	F. Pole, Holmer, Hereford ..	Royal Wilding.
Third Prize ..	107	W. R. Thomas, Nunnington, Hereford	Royal Wilding.
Fourth Prize ..	108	R.W.Wyatt, West Lambrook, Som.	Jaysies.
Reserve	86	H. H. Sealy, Cheddar, Som. ..	Hangdown.
Highly Commended	84	W. Hunt, Easton-in-Gordano, Som.	Royal George.
,, ,,	92	H. E. Dabinett, Somerton, Som.. .	Loyal Drain.
,, ,,	93	R. J. Denning, Ilminster, Som. ..	Red Jersey.
,, ,,	94	G. H. Hames, Tiverton, Devon. ..	Chisel Jersey.
,, ,,	100	W. R. Thomas, Nunnington, Hereford	White Norman.
,, ,,	105	D. Lewis, Raglan, Mon.	Broom.
,, ,,	111	S. H. Osborn, Nth. Cadbury, Som.	Yarlington Mill.

Class 5. MIXED VARIETIES. (48 *Entries*).

First Prize ..	138	J. P. Eley, Frampton Cotterell, Glos.
Second Prize ..	121	J. W. Hussey, Cullompton, Devon.
Third Prize ..	164	G. W. Green, Colyford, Devon.
Fourth Prize ..	140	J. T. Shield, Berkeley, Glos.
Reserve	120	S. Cursons, Dunsford, Devon.
Highly Commended	117	H. H. Sealy, Cheddar, Som.
,, ,,	127	S. J. Sheppey, Bradford, Som.
,, ,,	148	J. Bowditch, Stoke Abbott, Dorset.
,, ,,	149	S. B. Neill, Woodbury Salterton, Devon.
,, ,,	152	H. Hawkins, Brookthorpe, Glos.
,, ,,	155	J. Walters, Newton St. Cyres, Devon.
,, ,,	162	G. H. Sawtell, Kingweston, Som.

Class 6. PERRIES. (16 *Entries*).

			Name of Variety.
First Prize ..	166	J. P. Eley, Frampton Cotterell, Glos.	Eley's Nonsuch.
Second Prize ..	173	D. P. Morgan, Bushley, Worcs. ..	Butt.
Third Prize ..	170	H. Knight, Huntley, Glos. ..	Blakeney Red.
Fourth Prize ..	177	G. E. Bubb, Westbury-on-Severn, Glos.	Norton Butt.
Reserve	176	Clinch & Goddard, Upton-on-Severn, Worcs..	Butt.
Highly Commended	165	F. Pole, Holmer, Hereford ..	Holmer.
,, ,,	168	W. Weavers, Shrawley, Worcs. ..	Barland.
,, ,,	171	F. J. Ludlow, Westbury-on-Trym, Glos.	Coombe Pear.
,, ,,	172	S. W. Mullins, Raglan, Mon. ..	Blakeney Red.
,, ,,	178	J. N. Gwynne, Sutton, Hereford	Oldfield.

THE CULTIVATION OF WILLOWS ON SEWAGE FARMS.

By H. P. Hutchinson.

The wet conditions existing on all land devoted to the disposal of sewage considerably limit the choice of crops which can be grown economically and profitably thereon. An irregular system of cropping is generally practised in which green crops are interposed between frequent bare fallows, but these crops are regarded as of secondary consequence, the main object in management being to use the land in such a way as to secure the greatest absorption and purification of the liquid effluent prior to its discharge into the permanent water-courses.

Willows are grown with success on many sewage farms in the country. Failures which have occurred can generally be attributed to one or more of the following causes :—

The growing of unsuitable varieties.
Imperfect control of sewage liquid.
Lack of sufficient knowledge in the management of the crop.

All willows delight in a rich, deep, well watered soil. In providing great depth of soil for root range and large reserves of plant food, sewage conditions are eminently suitable for the crop, but as the water supply is frequently liable to be in excess of the plant's requirements, control of this factor to the extent of avoiding stagnancy for long periods is essential.

Disposition of Land and Soil Conditions.

As the removal of sewage is effected by gravity, land devoted to sewage disposal is always situated at a lower level than the area which is served. Consequently the quantity of sewage liquid is frequently considerably increased by the inflow of drainage water from surrounding land. As pollution of streams is prohibited by law, retention of the sewage liquid within the farm limits until, by sedimentation and soil absorption the necessary degree of purification of the final discharging effluent has been attained, is essential. No other economic crop can approach the basket willow in its suitability to such conditions.

An open-textured soil such as sand is the best as an absorbent and filter, but a choice of site for a sewage farm based on soil characters is seldom possible, since every district for its sewage disposal must utilise local land. For this reason the soils of sewage farms vary between the wide extremes of sands and clays.

Arrangement of the Willow Beds and Distribution of Sewage Effluent.

The willow crop should be grown as a series of oblong-shaped beds raised in the centres with gradual lateral slopes to the open dykes which separate them. The beds, as a general rule, should be so arranged as to have their greater lengths at right angles to the main sewage carrying channel. The dykes are made to communicate with this main channel and should be given a slight fall in the opposite direction so that the sewage water may travel freely along their full lengths. The widths of the beds and the widths of the intervening dykes should be in accordance with the type of soil present and the amount of effluent to be distributed. For heavy clay land where absorption and filtration by the soil are slow and a large surface for distribution is required suitable distances have been found to be 12 feet for the beds and 3 feet for the dykes. Similarly for porous sandy soil 24-30 feet land widths with 2 feet 6 inches to 3 feet widths for the dykes suffice. The depths of the dykes are usually 2 feet, measured at the sides. The soil of a sewage farm should be regarded as a filtering medium, filtered water being removed from the land by means of land drains. Under the best planned sewage farm systems a drainage system consisting of a series of pipe or clinker drains placed along the middle of each bed, 3-4 feet below the land surface and in a direction parallel to the longer sides, serve to discharge filtered liquid into a main pipe drain by means of which it is conveyed in a satisfactory condition as regards its pollution content into the water-course of the district. In cases where such a system cannot be installed, the removal of filtered liquid is achieved by means of open drains at suitable places and connecting with the neighbouring watercourses. In practice a satisfactory land disposal sewage system operates in this way :—

The sewage effluent from the settling tanks flows along the main carrier drain alongside the beds which are to receive it. The distribution of liquid is controlled by means of dams or sluice doors placed at suitable distances in the channel. Similar sluices are placed at the openings to the land dykes. By these means the liquid can be made to fill any desired dyke. The dykes are kept filled as indicated by the level of the liquid in them. Flooding of the entire beds is admissible at times particularly during the growing season when atmospheric conditions and rapid plant growth are

favourable to rapid removal of water, but care should be taken to avoid stagnancy of the crude sewage around the heads of the plants. Because of the injury which might arise, flooding of the beds should not be practised in winter. Willow heads have been killed by a fortnight's contact with crude liquid sewage. Water is removed by soil filtration, by direct surface evaporation and by plant absorption. It is arranged for the dykes to dry out completely at times when the sedimented matter is removed with hand shovels and thrown towards the middle of the beds. The latter thus become raised, increased in fertility, and ultimately capable of exerting a greater absorptive action.

Preparation of the Land for the Willow Crop.

Grass land can be best prepared for the crop by means of the plough. At the commencement of the operation the beds of the required width should be marked out and the ridge set in the middle of each land. The dykes should be dug out by hand at the open furrows and headlands and corners spade dug. The best time of year for this work is late autumn but winter and even spring ploughing is satisfactory provided the land is dry enough to carry horses and implements. The land when settled may be planted after the furrows have been levelled with light harrows, or on the plough furrows if harrowing has not been possible.

Planting.

The material used for planting consists of segments of rods one or two years old. The sets are pushed into the ground to a depth of about 8 inches in regular rows running parallel to the dykes The distances should be 19-22 inches between the rows and 15-18 inches between neighbouring plants in the same row. These variations in planting distances are due to the differences in space requirements of the several varieties of willows which may be planted. A further modification in row distances may be made in order to fully accommodate the beds. The outside rows of each bed should be planted 12 inches from the edges of the separating dykes. The land between these rows should be spaced out as nearly as will conform with the standard distances given. In this matter it would be preferable to err on the side of too close, rather than too wide, planting.

The length of set to be planted is important ; it is largely determined by the annual cultivation methods intended to be employed during the lifetime of the crop. In cases where cleanliness of crop can be maintained by the use of the spade and hoe as in garden cultivation, sets of 10-12 inches are sufficiently long. The crowns or heads of the plants which ultimately develop will rest

on, or be raised a few inches above, ground level. In the majority of cases it would be preferable to plant sets of 18 inches long whereby the heads will develop at distances of about 12 inches above the land surface. Under this system young shoots are not interfered with by growth of weeds in early spring owing to the high positions of the heads from which they arise.

Planting may be carried out at any convenient time between November and the end of March. A line may be used in planting.

Suitable Varieties.

Basket willows grown under sewage conditions are capable of producing very heavy yields, but the rods, in the case of the majority of varieties, although larger, are inferior in basket making qualities to those of the same varieties grown on good willow land ; they are more open grained and contain more pith and consequently are more liable to break when being twisted and bent by the basket maker.

Excessive deterioration in quality can be avoided if the hardest wooded varieties only are planted, because any loss in hardness would not reduce the working qualities of the rods below the point at which the basket maker would accept them. Any variety of willow would be suitable for planting provided it conformed with the following requirements :—

(*a*) Produced a satisfactory yield of rods.

(*b*) Produced rods of good working quality as green, brown, white or buff.

(*c*) Produced rods straight in growth with a minimum number of side shoots.

In addition, a suitable variety should produce the largest number of annual shoots per head, so that the closeness of growth combined with the dense foliage may act as a smother crop on the weeds below. The number of varieties possessing these characters is small. The variety " Black Top " (*Salix hippophaefolia*) is extensively grown on many sewage farms. It has the important characters of being able to produce rods of good quality either as Buff or White, and as a rule grows sufficiently dense to smother all weed below ; but it is subject to side shooting, is rather short and thick butted for its length. It is fairly readily saleable if well grown, but basket makers generally prefer other varieties for some classes of basket work. " Black Maul " (*Salix triandra*) grows well under sewage conditions. It usually yields heavy crops of big rods. The quality of the rods is good but the crop as a whole is deficient in providing sufficient cover for effectively checking

the growth of weeds. "Mottled Spaniards" (*Salix amygalina*) and other varieties of the Spaniard class are fairly satisfactory, their chief defect being a proneness to excessive side shooting. "Golden Willow" (*Salix alba*) has succeeded. It is a soft wooded variety unsuitable for peeling, but as "Green" it now meets with a ready sale at high prices as a tie rod for market garden produce. The variety "Harrison"—a hybrid of *Salix purpurea* and *Salix viminalis* produces a rod of exceptional hard quality when grown on ordinary willow land. It is a little known variety and has not been tried on sewage farms, but as it possesses all the characters required for sewage conditions success would be likely to result if it were planted.

For the past three years research work having as its object the increasing of the number of willow varieties suitable for sewage farm cultivation has been in progress at The Research Station, Long Ashton. Many new varieties are now being raised under a system of controlled breeding. It is probable that selections which are now being made from seedling willows will meet more fully these specific requirements.

Management of the Crop.

It is essential in the establishment of a newly planted willow bed that it be kept clean during at least the first two years from the time of planting. To this end the crop should be hoed during the summer. Weeds grow rapidly and strongly on sewage farms so that hoeings would need to be done more frequently than would be necessary on the usual type of willow land. In the third year and for all subsequent years the willow crop should be sufficiently dense to check adequately weed growth especially if supplemented by cutting the weeds with hooks during the summer months.

It may be anticipated that a number of cuttings will fail to grow. The blank spaces so formed should be filled with new sets in the spring of the second year. It is very important to avoid gaps in the crop throughout the lifetime of the bed (which may be twenty years or more) because of the opportunity which vacant spaces give to the introduction and establishment of weeds. Where plants die, long sets should be inserted at the time when the crop is being cut or at any time before the commencement of spring growth.

Cutting the Crop.

The crop of rods should be cut after the first fall of leaf and, generally in all subsequent years crops, should be taken annually. At times it has been found advantageous to allow the crop to

remain uncut for two or three years. Two and three year old sticks find a ready sale as material suitable for table and chair legs and for the supporting parts of various kinds of basketry. Deferred cutting has the further advantage of increasing the productivity of the plants in later years.

There is no operation in willow culture of greater importance or one more neglected in its proper execution than cutting. Cutters find it easier to detach the rods at places an inch or more from the the main stem of the plants rather than at a closer distance. A few years of this treatment results in the formation of irregularly shaped open crowns when, as in the case of a pollarded tree, various diseases are enabled to enter the plants, partial decay and premature death of heads ultimately occurring. The correct method of cutting is to insert the knife at a point as close to the main stem as possible. Little or no snag should be left. There is always a sufficient number of buds developed at the extreme base of a closely cut rod to provide shoots for the following year. By continued practice of this method close dome shaped heads are formed, the crowns continue healthy and more room is afforded to the workers.

Marketing.

A detailed description of the various methods employed in preparing willow rods for market is given in The Ministry of Agriculture's pamphlet "The Cultivation of Osiers and Willows." Briefly the rods are removed from the land as bolts or bundles. At later stages they are sorted and graded in sizes and sold as Green, Brown, White or Buff according to the requirements of the buyer and the opportunities which are afforded the grower in preparing them for sale.

The Cultivation of the Cricket-bat (*Salix alba var. caerulea*).

Within recent years it has been found that the conditions existing on many sewage farms are well suited to the growing of the cricket-bat willow. Two lines of development are possible, viz. :—

1. The production of cricket-bat willow sets.
2. The growing of bat willow trees for timber.

The Production of Sets.

A bat willow tree commences its growth as a long set 12-15 feet in length and about 1 inch in diameter at its base.

From the results obtained from the experimental work carried out at Long Ashton the following advice on the problem can be given. Segments of branches about 3 feet in length and of a

diameter of 2-3 inches may be planted firmly to a depth of one foot in rich soil at distances apart of about 4 feet. Sets such as these will produce numerous shoots during the summer following spring planting. Each set should be allowed to develop not more than four shoots, the rest being rubbed off when sufficiently long to enable the best selection to be made.

Under suitable conditions these rods will attain a length of 12-15 feet in 3 years when they can be cut and sold for planting in permanent quarters.

The Production of Timber.

Banks, borders and waste spaces usually present on sewage farms are frequently suitable positions for bat willow trees. Long straight sets should be planted to a depth of about 2 feet at from 25 to 30 feet distances. No further attention to the trees is needed except the removal of numerous buds which develop on the stems for the first few years after planting. The trees should be ready for cutting at the age of 15 to 20 years.

The production of cricket-bat willow sets would prove profitable at the present time owing to the great demand, the high prices (2/6—5 - per set) which are now being realised and the relatively short time required for their development.

As timber a longer wait for financial returns would be necessary, but from the high prices which have prevailed for many years, and the fact that the trees would be growing without expense on land which could not well be used for any other purpose, bat willows would ultimately prove a valuable source of revenue.

REPORT ON ADVISORY WORK, 1927-28.

Each successive year since the war has seen a new record created for the number of enquiries received during the year. This sequence has been maintained for the year under review, although the increase in number of enquiries over the previous year is not large. The rate of increase has indeed shown a progressive falling off for the last three years, and it seems probable that the limit of activity with the present strength of staff available has almost been reached.

The following table gives the numbers of enquiries submitted during the last six years.

	Year ending September 30th.					
	1923	1924	1925	1926	1927	1928
Gloucester (including Bristol)	136	137	194	262	183	202
Hereford	62	107	88	91	115	97
Somerset	141	130	395	276	254	308
Wiltshire	66	24	117	175	104	104
Worcester	48	78	78	103	168	161
Other areas	205	195	222	309	478	495
	658	671	1094	1216	1302	1367

Included in the figures under " other areas " are enquiries received from Devon and Monmouth, both of which contribute annual grants to the Long Ashton Institute, and from Dorset, which participates in the scheme for Local Instruction in Cider-making. None of these counties rank officially as part of the Bristol Province.

This list does not indicate the very numerous enquiries dealt with in personal interviews during survey work, local investigational work, shows, etc., nor those relating to fruit and vegetable preservation and products, which are dealt with by the Campden Station. Also, as in previous years, no figures for enquiries received under the heads of Agriculture, Economics or Dairy Bacteriology have been included, so that the statistics given may be comparable with those of earlier years before those subjects were dealt with.

Special attention should be directed to certain items in the sectional reports.

The work of the Advisory Chemist on Sugar Beet is being continued and this year the co-operation of the Royal Agricultural

College has been obtained in connection with the Clamping Experiment, a special area of sugar beet having been grown on the College Farm for that purpose.

The work in connection with the intensively managed grass land is now arousing considerable interest throughout the Province, and many requests for lectures, both inside and outside of the Province, have been received, partly as a result of this work. The large scale grazing trial in Wiltshire has aroused much interest amongst local farmers, a large number of whom, at the end of the grazing season, paid a visit to the plots, and indicated lines of investigation which they would like us to introduce, as a help towards the solution of some of their own immediate difficulties.

The work in Agricultural Economics was considerably interfered with during the year by changes in Staff, not only in the headship of that section of the work, but also in the student-assistantships. Such sudden and wholesale changes make one realise the necessity of obtaining more permanence in the nature of these appointments, so as to ensure more continuity in the work. After repeated applications for financial assistance to carry out the classification of farms under this scheme, we are still without an officer for this work. In view of the developments, and the keenness now shown by the farmers participating in these schemes of work, it is unfortunate that we are unable to make the fullest use of all the data obtained from the accounts.

The Provincial Advisory Conference continues to act as the "clearing house" for all work affecting both Advisory Officers and County Staffs. The Joint Conference with the West Midland Province was again held this year, the meeting taking place at Bristol. Visits were paid to the Research Station, Long Ashton.

For a scheme of comparatively recent establishment that for Local Instruction in Cider-making, referred to in some detail in the last report, is developing rapidly and very satisfactorily. The services of the Instructor have been in great demand, and the value of his work may be seen in the striking improvement in the quality of the cider made by the farmers who have sought his assistance. Some have been successful in obtaining awards at open Competitions for cider and perry at various shows, and it is believed that for the first time, at any rate in recent years, entries from Dorset, one of the counties included in the scheme, have found places in the awards list. Another testimony to the value of work on these lines is visible in the amount of attention being given to farm orcharding and the perceptible improvement resulting therefrom.

The work of the second Fruit Soil Survey, began in the previous

year, is well in hand and progressing satisfactorily. This survey is concerned with soils in the Lower Lias Formation and is, like its predecessor, yielding results which cannot fail to benefit materially many fruit growers and market gardeners whose land is on that Formation.

There are two outstanding features of interest associated with the Advisory Work on Pomology and Economic Entomology, those concerned with strawberry culture and the use of egg-killing winter spray fluids respectively. As a result of the application of knowledge gained during the work of recent years on the pathology of the strawberry plant there has been a distinct improvement in the standard of health and vigour of the strawberry beds in many instances, and this is being assisted to a notable extent by the Scheme of Certification of Strawberry Plants which the Ministry has now put into force. The tar-distillate winter washes have now become well established among fruit-growers as a means of killing the eggs of many insect pests. Investigations on this type of spray fluid made recently at Long Ashton have resulted in the preparation of a wash of standard formula and notable efficiency according to laboratory tests. This has been tested out under field conditions, in the Bristol Province, during the past season by members of the Advisory and Research Staffs attached to the Station, and the results have substantiated those of the laboratory trials.

The acceptance by Dr. R. M. Nattrass, the Adviser in Economic Mycology, of a post in Egypt, early in the year, imposed a heavy handicap on this section of the Advisory work. His successor, Mr. L. Ogilvie, who was unable to take over the duties of the post until May, brings valuable experience of similar work gained in Bermuda, but since his arrival has necessarily been obliged to devote a large part of his time to gaining acquaintance with the local conditions and problems of the Province. During the interim period the work was carried on so far as time permitted by Mr. Marsh, the Research Mycologist of the Long Ashton Station, whose previous close association with the work of Dr. Nattrass enabled him to do this with the least possible dislocation.

The most noteworthy event of the year in respect of the Willow Advisory work has been the establishment of Variety Trial plots in the centre of the Somerset willow-growing area. These have been organised by the Somerset County Council in consultation with the Willow Officer.

The following Sectional Reports serve to show the nature of the advisory work carried out during the year.

The sections dealing with Agriculture, Agricultural Chemistry,

Agricultural Economics, Dairy Bacteriology, Economic Entomology, Economic Mycology and Willow Culture have been respectively contributed by Prof. J. A. Hanley, Mr. A. W. Ling, Mr. C. V. Dawe, Mr. C. A. MacEacharn, Mr. L. N. Stainland, Mr. L. Ogilvie and Mr. H. P. Hutchinson, the Advisers in those subjects, while the section relating to Cider Instruction has been contributed by Mr. P. T. H. Pickford, Instructor in Cider-making for the Counties of Dorset, Monmouth and Worcester.

Agriculture.

The appointment of the Chief Advisory Officer as Principal of the Royal Agricultural College, Cirencester, has definitely brought the work of that College into close touch, not only with the advisory work at Bristol, but with the educational work in those counties adjoining the College, especially Gloucester and Wiltshire.

(1) *Grass Land.*

The Chief Advisory Officer judged the first Pasture Competitions held in the counties of Cumberland and Westmorland. The grass land work in connection with County Educational Schemes is referred to in other sections of this report.

(2) *Clean Milk Competitions.*

The Chief Advisory Officer has, with the assistance of the Advisory Chemist and the Dairy Bacteriologist, judged the Wiltshire and Gloucestershire Clean Milk Competitions, in which there was a total of 72 competitors.

(3) *Farm Management.*

Problems on Farm Management, embodying both technical and financial sides, continue to be submitted and the work so far carried out and the data already accumulated by the Agricultural Economist are found to be of the greatest value.

(4) *Agricultural Shows.*

Although the Show of the Bath and West Society was this year held outside the Province (in Dorset), the University was requested by the Society to co-operate with Reading University and the County Organiser for Dorset, in preparing the educational exhibit. Examples from the Society's own grass land experiments, and an exhibit in connection with sugar beet were accordingly staged at Dorchester. The exhibits at the County Shows in the Province were unusually successful this year, and possibly owing to better weather, were attended by a larger number of farmers than usual.

(5) *Egg Marketing Conference.*

The Secretary of the Provincial Advisory Conference (Mr. A. W. Ling) organised a very successful Egg Marketing Conference, which was held at the University and which was attended by representatives of the Ministry, County Authorities, National Farmers' Union and various bodies interested in the production and distribution of eggs.

(6) *Lectures.*

The following lectures were given during the year by the Chief Advisory Officer :—

Gloucestershire	1
Other areas	17

Agricultural Chemistry.

During the year 221 requests for advice were received. The sources of these are shown in the following table :—

Gloucestershire	41
Herefordshire	29
Somerset	75
Wiltshire	59
Worcestershire	6
Other areas	11
	221

The total number of samples examined was made up as follows :—

Soils	351
Manures	19
Feeding Stuffs	34
Limes and Limestones	17
Grasses	221
Sugar Beet	237
Mangels	29
Miscellaneous	20
	928

Where advisory visits were deemed to be necessary, in most cases, such visits were made in the company of the Agricultural Organiser of the County concerned.

Investigations in Progress.

(1) *Grass Land.*

The investigations outlined in the previous report have been continued during the present season, and a large amount of growth and chemical data has been collected in connection with the intensive grazing trial at Longleat. It is hoped to continue these grassland studies for some time to come.

(*a*) *Intensive versus Extensive Grazing Trial*—at Longleat Park, Wiltshire.—Sampling of the grass from the sixteen plots at this centre has been continued throughout the growing season, and these samples are being analysed. Grazing records as "cow-days" per acre have been kept. A large party of farmers recently visited the plots and they were keenly interested in the experiments.

(*b*) *Variety Trials of Rye Grasses and Cocksfoot*—at Melksham, Wiltshire, and Long Ashton, Somerset.—These trials which were described in the previous report, are being continued.

(*c*) *Eradication of Black Grass* (*Alopecurus Agrestis*) at Long Ashton, Somerset.—These trials are being continued.

(*d*) *Bath and West Society's Grass Land Experiment.*—This experiment has now been concluded and a full report appeared in the Journal of the Bath and West Society (1927-28). By the courtesy of the Society, a large number of reprints of the report were made and most of these have been circulated to those interested.

(*e*) *County Grass Land Experiments.*—An active part has been taken in the County Schemes for grass land improvement. As indicated in previous reports, soil samples from the experimental plots have been analysed in the laboratory. It has been made a practice to retain soil samples of all grass land plots for future reference.

(*f*) *Pasture Research Committee's Experiments.*—At the request of this Committee, two trial centres have been established in the West of England, and three-weekly grass samples have been collected, dried, and despatched to Cambridge for further analysis.

(2) *Arable Land.*

(*a*) *Sugar Beet.*

(1) *Field Trials.*—The following centres have been established in the Province this season:—

	Glos.	Herefd.	Som.	Wilts.	Worcs.	Total.
Cultivation Trials*	–	–	1	1	–	2
Time of Application of Nitrogen*	2	–	2	3	–	7
Quantity of Nitrogen*	2	3	3	2	1	11
Form of Nitrogen†	4	3	1	–	4	12
Miscellaneous	1	–	–	2	–	3
	9	6	7	8	5	35

*According to the Scheme of the Ministry of Agriculture and Fisheries.
†Bristol Provincial Scheme.

The same type of data will be collected from these trial centres as was obtained last year.

A University Bulletin was published, containing the results of last season's trials. Copies of this bulletin are obtainable gratis on application.

(*b*) *Sugar Beet Investigations.*

(2) *Clamping Experiment.*—At the request of the Ministry, and in co-operation with the Universities of Oxford and Cambridge, this trial will be continued for another season. A joint report on last season's result has recently been submitted to the Ministry.

(3) *Analytical Methods.*—In conjunction with the Sugar Beet Analysis Sub-Committee of the Agricultural Education Association, and by means of a special grant from the Ministry, a detailed investigation of the various methods of obtaining the pulp and determining the sucrose of sugar beet is being carried out. An interim report has been issued and a final report will be made later.

(3) *Liming Experiments.*

No further trial centres have been established this season.

(4) *Miscellaneous Problems Investigated.*

(*a*) Sugar content of different varieties of mangels.
(*b*) Agricultural value of local supplies of limestone.
(*c*) Agricultural value of various waste materials from factories.
(*d*) Taints in milk.
(*e*) Cleaning materials for dairy utensils.
(*f*) Suitability of certain samples of sharps for pig feeding.
(*g*) Arsenic content of hops.
(*h*) Lamb Disease in Somerset—in conjunction with the University of Leeds.
(*i*) Eradication of weeds.
(*j*) Failure patches in arable fields.
(*k*) The use of Calcium Cyanamide as a nitrogenous fertiliser.

(5) *Mole Destruction Experiment.*

A small area of land at Long Ashton had been fenced in and the various methods of destroying moles—viz., gassing, poisoning and trapping—are being investigated. This work is still in progress.

General.

(1) *Clean Milk Courses for Sanitary Inspectors.*

At the request of the Dairy Branch of the Ministry of Agriculture, the Advisory Chemist, in conjunction with the Dairy Bacteriologist

and a Dairy Inspector of the Ministry, has arranged these courses. Successful courses have been held as under :—

Centre.	Dates.	No. of Inspectors Attending.
Worcester	Sept. 20th – Oct. 11th, 1927	23
Gloucester	Oct. 14th – Nov. 1st, 1927	11
Hereford	Nov. 22nd – Dec. 2nd, 1927	19

Another course has just been arranged to take place atTrowbridge, (Wiltshire) from November 9th to November 26th, 1928.

(2) *Shows.*

Educational exhibits were prepared for the Bath and West Show at Dorchester, the Three Counties Show at Hereford and the Wiltshire County Show at Salisbury. The Advisory Chemist was in attendance at these three shows and dealt with enquires.

(3) *Sugar Beet Conference.*

The Advisory Chemist arranged a Conference of Sugar Beet Growers, which was held in the University of Bristol on February 23rd, 1928. The Vice-Chancellor presided over the proceedings—a full account of which has been published in the Sugar Beet Bulletin to which reference has previously been made.

(4) *Lectures.*

Town or Village.	Association or Society.	Date.	Subject.
Gloucester ..	Sanitary Inspectors ..	Oct. 14th, 1927 ..	"Milk as a Food—various forms of milk—clean raw milk."
Gloucester ..	„ „ ..	Oct. 24th, 1927 ..	"Milk Legislation."
Gloucester ..	„ „ ..	Oct. 24th, 1927 ..	"Chemistry of Milk."
Bristol ..	Workers' Education Association ..	Nov. 12th, 1927 ..	"Science as applied to Agriculture."
Hereford ..	Sanitary Inspectors ..	Nov. 22nd, 1927 ..	"Milk as a Food—various forms of milk—clean raw milk."
Hereford ..	„ „ ..	Nov. 24th, 1927 ..	"Milk Legislation."
Hereford ..	„ „ ..	Nov. 24th, 1927 ..	"Chemistry of Milk."
Cullompton ..	Agricultural Discussion Society ..	Feb. 13th, 1927 ..	"Sugar Beet Growing and Experiments in the West of England.'

Agricultural Economics.

The following Research and Advisory Work in Agricultural Economics was carried out in the Bristol Province :—

(1) *Farm Management Studies.*

(*a*) *Costing.*—Detailed cost accounts have been kept for seven farms, for the year 1927-28. Of these four were completed by the 30th September, and reports sent to the farmers concerned.

On November 24th, 1927, a meeting was held at the University of those farmers who had received their cost accounts and reports for the year 1926-27. The Vice-Chancellor and members of the Advisory Staff were present. The discussion by these farmers of the results of the cost accounts proved of great interest.

The University entertained those present to luncheon and tea.

(*b*) *Simple Accounts—Somerset.*—Simple financial accounts for the year 1926-27 (relating to 120 farms) have been analysed. In each case a report has been sent to the farmer concerned, together with tables relating to all the farms in his particular soil group. In this way each farmer has been able to see his relative position in the group.

(*c*) *Wiltshire Agricultural Accounting Society.*—The Second Annual Meeting was held on October 10th, 1927. The number of members on that date was 69. Mr. M. C. Thorne, who resigned his position as Student-Assistant at Bristol in November, 1927, in order to acquire a Surveyor's business at Reading, was appointed Advisory Officer to the Accounting Society, under the general direction of the Advisory Economist at Bristol. In the winter of 1927-28, district meetings to discuss the results were held at Salisbury, Devizes and Swindon, these centres being within easy reach of the members. In each case there was a good attendance and an interesting discussion ensued. It is noteworthy that several members attended more than one meeting.

Each farmer, during the year, received an analysis of his own accounts with the report thereon, and, at a subsequent date, comparative tables similar to those sent to the Somerset farmers.

(*d*) *Agricultural Survey.*—Reference was made in the report for the previous year that an agricultural survey was considered to be extremely desirable as a basis for the proper classification of farms, and for the satisfactory interpretation of the results obtained from the analysis of the financial accounts. The additional grant for this work has, unfortunately, not yet been received, so that it has not been possible to proceed with this survey.

The facts that the Wiltshire Agricultural Accounting Society is making endeavours to extend its membership and that the number of farm accounts dealt with at Bristol is steadily increasing, make the need for a survey of this kind still more urgent if economic problems are to be satisfactorily solved.

(*e*) *Sugar Beet Investigation.*—The 46 farms in Herefordshire and Worcestershire, referred to in the previous report, were again visited periodically during the past year, and data of costs and yields collected for the 1927 crop. The information thus obtained was tabulated and analysed, and a report sent to each of the farmers concerned. The collective results were also sent to the Agricultural Economics Research Institute, Oxford, and formed part of the data upon which a report has just been published by that Institute.

The work in connection with the 1928 crop has been continued by the time sheet method.

(2) *Correspondence Course in Farm Book-Keeping.*

This course was repeated in Gloucestershire and Wiltshire.

(3) *Lectures.*

The following lectures were given during the winter, by Mr. E. P. Weller :—

1927.		
November	14th—"Factors affecting Farm Profits" ..	Chesterfield Agr. Discussion Society.
„	17th—"The Economics of Farm Management"	Land Agents' Society Birmingham.
„	28th—"Factors affecting Farm Profits" ..	Agric. Education Com., Welshpool.
1928.		
February	13th—"Factors affecting Farm Profits" ..	East Anglian Institute of Agric., Chelmsford.
„	27th—"Factors affecting Farm Profits" ..	National Farmers' Union Shepton Mallet.
„	28th—"Factors affecting Farm Profits" ..	National Farmers' Union Wincanton.
March	24th—"Talk on Marketing"	Mere Discussion Society.

In addition, a course of lectures on methods of keeping cost accounts was given to rural craftsmen, at the request of the Somerset Rural Community Council.

Dairy Bacteriology.

(1) *Clean Milk Competitions*, 1928.

Four counties in the Bristol Province have held Clean Milk Competitions. The Worcestershire and Wiltshire Competitions

extended over a period of 6 months, and those in Gloucestershire over a period of 3 months. Somerset held two Competitions each of 4 months' duration ; one of these was for milk sellers and the other for butter-makers and cheese makers.

The Wiltshire Clean Milk Competition contained a special class for farmers using the " open-air " system and milking in moveable cowsheds. Ten entries were received in this class.

The details of entries, etc., are shown in the following table :—

County.	No. of Competitors.	No of Samples Received.
Wiltshire	41 ..	434
Somerset	68 ..	414
Gloucestershire	31 ..	187
Worcestershire	12 ..	108
	Total ..	1,143

One bottle only is used when submitting a sample to the laboratory The milk is " plated out " and set up for B.coli, then some of the milk is poured into a sterile bottle for the Keeping Quality Test. The percentage of butter fat is estimated on the remaining quantity of milk. This method is simple and satisfactory.

The results of the recent Clean Milk Competitions seem to indicate that the farmers are settling down to the production of a clean milk. There were more samples within the standards laid down for Certified Milk, and there were fewer " freak " counts. Much greater consistency was shown by competitors than in previous competitions.

(2) *Advisory Work Arising out of Clean Milk Competitions.*

The only advisory work arising from the Competitions has been in connection with cases of apparently inexplicable high bacteriological counts, and all were problems of the producer.

A considerable amount of work carried out during the past 18 months has proved to be very useful in the recent Clean Milk Competitions, for by careful examination of the plates, it has been possible to advise the farmer, through the County Agricultural Education Authorities, when he had a cow (or cows) suffering from undetected udder trouble.

In this way it has been possible to assist the farmer to a great extent and, in every case investigated, to isolate cows with udder trouble giving milk with a high bacterial content.

In one advisory case the contamination was introduced through the end of the pipe leading from the container to the cooler, scraping up dried milk, etc., from the sides of the too narrow hole in the wall, through which the pipe was passed.

(3) *Advisory and Investigational Work.*

There has been an increase in the number of samples examined under the above heading. Most of the problems investigated have been traced to udder trouble or insufficient sterilisation of some part of the equipment. A considerable number of samples has been examined in connection with the Hosier Open Air Dairies, and it is hoped that further and more extensive work will be carried out next year.

Advisory samples have been examined as follows :—

Chemical	81
Bacteriological	253
Tubercle Bacilli	17
Mastitis, etc.	92
B. coli (water and milk)	9

Nineteen Advisory visits to farms have been made by the Dairy Bacteriologist.

(4) *Agricultural Shows.*

Exhibits were staged by the Dairy Bacteriologist, at the Three Counties Show at Hereford, and the Wiltshire Show at Salisbury.

(5) *Lectures.*

Three courses of lectures for Sanitary Inspectors have been held in this Province—at Gloucester, Worcester and Hereford. These lectures were well attended, a total of 53 Sanitary Inspectors and others being present.

A course of lectures is to be held at Trowbridge, and 22 Sanitary Inspectors have already signified their intention of attending the lectures.

The courses held have proved a great success. Many of the Sanitary Inspectors have expressed desires for a further and more advanced course to be held, and the majority are showing more interest in the importance of *methods* in the production of a milk with a low bacteriological count and of a good keeping quality.

Summary of Samples Examined.

Wiltshire Clean Milk Competition	434
Somerset „ „ „	414
Gloucestershire Clean Milk Competition	187
Worcestershire „ „ „	108
Bacteriological	695
Chemical	1162
Tubercle Bacilli	43
Mastitis, etc.	112
B. coli	9
	3,164

Cider and Other Fruit Products.

In view of the increasing number of enquiries relating to fruit products other than cider, it has been deemed desirable to make the heading of this section more comprehensive than the limited title, "Cider," which has been the form used in previous reports. The statistics appended are comparable to those under this head in the earlier reports, for the enquiries relating to products have regularly been included with Cider hitherto.

The number of enquiries dealt with by correspondence during the year was 369, including 102 resulting from the Local Instruction Scheme, referred to in the Instructor's Report appended.

Their sources were as follows :—

Gloucester (Including Bristol)	31
Hereford	15
Somerset	59
Wiltshire	3
Worcester	55
Other areas	206
	369

The apparently large proportion of enquiries from districts ouside the Bristol Province is mainly accounted for by the numbers from Devon, Dorset and Monmouth, counties directly associated with Long Ashton for the subject of Cider. The enquiries from those three counties number over 100.

Each year shows a widening of interest in cider-making and related subjects, and an increasing number of overseas enquiries is being received. During the year under review they have come from North and South America, South Africa, Australia, India, Portugal, Denmark, Jersey and Ireland. There is also a constant succession of individual visitors to Long Ashton, seeking information, irrespective of the large numbers attending on the Annual Tasting Day and other occasions, when organised parties have been arranged. Several visits to cider-making factories and orchards have been necessary in connection with the advisory side of the work. Attention was called in last year's report to the resulting inevitable interference with the research work on this subject. The position becomes continuously more serious and threatens to end in this Department of the Station lapsing into nothing more than an Advisory Centre. This being the only Station in the Empire equipped for research in the subject, there is thus an immediate need for additional staff.

The range of the enquiries has been very wide, covering all phases of the industry. No novel features of special interest have arisen, and most questions raised have been mentioned in previous reports.

Cider Instruction.

Enquiries Received by Post.

Source of Enquiries.

Dorset	41
Monmouth	21
Worcester	40
	102

Nature of Enquiries.

*Applications for Special Advisory Visits	15
General Management of Cider	17
Bottling of Cider and Perry	22
Selection of Blending of Fruit	20
Filtering of Cider	10
Disorders of Cider	6
Preparation for Exhibits for Show Purposes	9
Orchard Management	3
	102

Number of Samples of Cider Analysed in connection with Advisory Work	35
Number of Varieties of Apples Tested for Quality	17

*Applications for Regular Advisory Visits are made, for the most part, during the course of the work in the counties apart from those received by post.

Visits Paid to Farmers.

The number of visits paid to farmers was as follows :—

Dorset	80
Monmouth	79
Worcester	87
Total	246

Demonstrations and Lectures.

Demonstrations of cider-making were held during the cider-making season, at the following centres :—

Dorset.	
Stoke Abbott	(15)
Melplash	(9)
Netherbury	(12)
Monmouth.	
Twyn-y-Sheriff, Raglan	(14)
Mathern	(10)
Mitchell Troy	(16)
Llangattock, Lingoed	(30)
Worcester.	
Corse Lawn, Tewkesbury	(16)
Newnham, Tenbury	(11)

The figures in brackets indicate the number of farmers attending on each occasion.

A lecture on " The Production of Cider," was given in November, 1927, to the students at Usk Institute. A similar lecture was also given to the Young Farmers' Class, in Worcester, in January, 1928.

A demonstration on filtering cider was held in March, at Welland, Worcester.

Observations on Visits and Enquiries.

Present Position of Cider in the Counties. Although it was found that the art of cider-making was on the whole more advanced in Worcestershire than in Dorset and Monmouth, satisfactory progress has been made recently in the two latter counties.

In Dorset especially great strides have been made. A special effort was made last season to discover the standard of bottled cider which could be produced in this country. Several lots of cider were made under the Instructor's supervision, and each lot in turn was filtered at the appropriate specific gravity. For this purpose a filter was lent by Long Ashton Research Station. Very successful and profitable results were obtained from this experiment, and a very favourable report on the quality and the possibilities of this cider was given. Comparatively small quantities of bottled cider were produced in this way, but there will be a considerable increase in the production of this type of cider during the coming season. Farmers in West Dorset have shown considerable interest in this experiment, and are now making their own arrangements for filtering their cider.

It appears desirable that work on similar lines to that carried out in Dorset last year should be done during next season in parts of Monmouth in order to help farmers in some districts to produce a more valuable cider. Although some very fine bottled cider is produced in Monmouth, in many districts little progress has been made as yet in modern cider-making.

In Worcester, where cider-making on the whole is practised on more scientific lines than in Dorset and Monmouth, problems of a more advanced nature are encountered. There are, however, a few districts even in this county where the newer practices, based on scientific principles, are only just being introduced. In all these backward districts assistance is being given towards the selection of the fruit available by analysis of juices taken from samples of the apples, and advice is given in particular cases on the blending of the varieties.

Filtering Cider. The practice of filtering cider to arrest fermentation at the appropriate specific gravity is becoming more general amongst farmer cider-makers who make considerable quantities of

cider. Although excellent sweet bottled cider is produced without filteration by the careful selection of varieties and the careful management of the juice during the fermentation, yet the practice of filtering even with this type of cider does make the control of fermentation less precarious, and is generally being adopted by the farmer.

Bottled Cider. There was a great increase in the amount of bottled cider produced in the counties during the season. Where good bottled cider is produced, there appears to be little difficulty in its disposal. Farmers generally commence with a small private sale in the first year in which they bottle cider, and in most cases it has been found that their sales increse year by year according to the merits of the cider produced.

Disorders of Cider. Several cases of cider sickness have been dealt with during the season. In all cases the cider attacked with this disorder was found to be cider of low acidity, with a very slow rate of fermentation, and had been bottled at a high specific gravity. In cases where sickness has been found or suspected, assistance has been given towards eliminating further risk of this disorder by advice on the judicious blending of varieties to correct the acidity of the juice, and on the control of the fermentation of the juice in order to reach a lower specific gravity at bottling time.

Only one or two cases of ropy cider were found this season. An interesting experiment on the improvement of ropy cider by pasteurisation was carried out in one particular case, where a considerable amount of cider in bottle became ropy. This cider after being pasteurised in bottle was quite normal in flavour and appearance.

Orcharding. During the summer the trial cider orchards were again inspected, and notes were taken on the growth and the cropping of individual varieties in the different districts. In Dorset a new trial cider orchard is to be planted during the coming winter. Many farm orchards were visited during the summer, and advice was given on their mangement.

Show Exhibits. The Instructor was in attendance with an exhibit at the following Agricultural Shows :—

The Bath and West Show, Dorchester.
The Bedwelty Show, Blackwood, Monmouth.
The Abergavenny Horse Show, Abergavenny.
The Melplash Agricultural Society Show, Bridport, Dorset.
The Wimborne and Blandford Show, Wimborne, Dorset.
The Three Counties Show at Hereford was attended.

In May, the Instructor was invited to join a party organised by the National Association of Cider Makers, in a tour of the wine and cider districts of Germany where a very interesting and profitable time was spent.

Pomology.

The pomological enquiries received through the post for the year totalled 139, being distributed as follows :—

Gloucester (including Bristol)	22
Hereford	6
Somerset	37
Wiltshire	7
Worcestershire	14
Other areas	53
	139

The number shows a decrease of 43 as compared with the previous year. As pointed out, however, in the last Report, a large proportion of the advisory work in this subject is not included in these statistics, since many enquirers pay personal visits to the Institute to obtain advice and information, and various members of the staff frequently visit growers at their own farms ; and it is probable that the volume of work has actually been greater, rather than less.

The most numerous enquiries relating to soft fruit have been connected with culture and nomenclature in the case of strawberries and gooseberries, with a few on red currants.

In connection with tree fruits many enquiries have been received on bark ringing, and some on stocks and the establishment and management of grass orchards. A number of enquiries have also been received on spraying and dusting machinery, and tractors for horticultural work.

Horticultural Chemistry.

Sources of Enquiry.

Gloucester (including Bristol)	14
Hereford	6
Somerset	18
Wiltshire	3
Worcester	11
Other areas	23
Total	75

Nature of Enquiries.

(*a*) *Soil Manurial Enquiries.*

Orchard and Fruit Plantation Soils	30
Greenhouse Soils	4
Market Garden Soils	2
Garden Soils	7
	43

(*b*) *Miscellaneous Soil Problems.*

Soil Conditions producing Chlorosis of Trees and Garden Crops	3
Soil Conditions producing Leaf Scorch of Fruit Trees; and Control Measures against Leaf Scorch	4
Soil Conditions producing Failures of Fruit Trees	2
Soil Conditions producing Failures of Market Garden and Garden Crops	6
Suitability of Soils for Fruit Growing	4
Soil Conditions in relation to Die-Back in Plums	1
Soil Acidity in relation to Fruit Crops	1
	21

(*c*) *Miscellaneous Enquiries.*

Manurial Value of Sewage Sludge	1
Manurial Value of Sample of Hoof	1
Manurial Value of Beech Leaves	1
Manurial Value of Spent Manure from Mushroom Beds	1
Prices of Fertiliser Mixtures	1
Effect of Manures on Biennial Cropping of Coffee	1
Nitrogen and Phosphorus Contents of Average Black Currant Crop	1
Humus Content of Leaf Mould	1
Use of Cover Crops in Fruit Plantations	1
Replanting of Old Orchards	1
Crackling of Apples	1
Keeping Quality of Consignment of Apples	1
	12

Observations on Enquiries.

The total number of enquiries received shows a slight increase over the number dealt with during the previous year, while the proportion of the enquiries received from areas outside the Bristol Province are practically identical for the two years. The enquiries included two from the Colonies and one from Holland.

As in previous years, the subjects of enquiry related chiefly to points in connection with the manuring of fruit plantations, to the suitability of soils for fruit growing, and to cases of failures of fruit trees.

Thirteen cases related to total failures or poor cropping in market gardens and gardens. In these cases the main source of trouble appeared to be shortage of stable manure, resulting in potash starvation in certain crops, notably in potatoes.

Miscellaneous enquiries mostly related to manurial problems and the manurial values of various materials.

Special Investigations in Progress.

(1) *Field Experiments on "The Manuring of Fruit Trees, Bush Fruits and Vegetable Crops":—*

(*a*) Effect of Potash on Leaf Scorch (Expts. contd.)—in Worcester, Hereford and Somerset.

(*b*) Effect of Potash and Lime on Leaf Scorch on an acid soil—in Worcester.

(*c*) The Effects of Nitrogenous Fertilisers—Nitrate of Soda and Sulphate of Ammonia—on Trees under Low Cultivation and Grass (Expts. contd.)—in Worcester and Hereford—(and extended) in Somerset.

(*d*) The Effects of Artificial Manures on Asparagus (Expts. contd.)—in Worcester.

The results obtained from potash manures on leaf scorch continue to be very marked. Lime has not effected any reduction in scorch on gooseberries after two seasons in a case where the soil is strongly acid in reaction, whereas the bushes have responded markedly to potash manuring.

The primary object of the experiments on the use of nitrogen on fruit trees under "low cultural" and "grass" conditions is to test the method as a means of producing high quality dessert apples.

(2) *Experiments on the Control of Lime-induced Chlorosis in Plums and Apples, and of a Chlorosis of Plums associated with Potash Deficiency and Waterlogging*– in Worcester and Somerset. —The treatment of "grassing down" in cases of lime-induced chlorosis continues to be entirely effective. Marked results from potash manuring have been obtained in the cases of chlorosis of plums associated with apparent potash deficiency.

(3) *Survey of Soils in Fruit and Market Garden Areas on the Lower Lias Formation.*—The work of soil mapping has been practically completed in the Pershore and Evesham areas. Good progress has also been made with the pomological survey in these areas. As the result of the work carried out, several important problems are under investigation and considerable, advances have been made with certain of these.

There is a marked correlation between certain soil conditions and the success and failure of various classes of fruit trees.

Economic Entomology.

The number of letters of enquiry dealt with during the year was 274, distributed among the counties as shown below :—

Gloucester (including Bristol)	47
Hereford	16
Somerset	51
Wiltshire	17
Worcester	42
Other Counties	101
Total ..	274

The number of farms and plantations visited was 167.

The number of enquiries shows an increase of 65 when compared with those dealt with during the previous year. Letters from other counties consisted almost entirely of enquiries concerning strawberries, and it is to enquiries regarding strawberries that the above-mentioned increase is largely due. Of the total number of letters of enquiry, the Research Entomologist has received 39, and he has made himself responsible for 30 of the visits to farms and plantations.

Since the Adviser has been working a large part of his time on strawberry problems, the Research Entomologist has assisted with the Advisory work in the manner stated.

The most serious pests of the year were as follows :—

Capsid Bug (*Plesiocoris rugicollis*). This pest continues to spread to new plantations. The most notable feature of its activities is the serious damage caused by it in two plantations in Somerset. Up to this year Somerset has continued to be relatively free of the pest. No records have been received from Wiltshire.

Ground Beetles (*Harpalus ruficornis*). This pest was equal in severity, in the Cheddar district, to last year. The pest is distributed very unevenly.

Strawberry Aphis (*Capitophorus fragariae*). This pest has been more serious than last year. No migration of the aphids was observed this year. Reference is made later to special investigations on this pest.

Pear Midge (*Contarinia pyrivora*). This pest continues to be severe.

Woolly Aphis (*Eriosoma lanigera*). This pest was more severe than during last year, some exceptionally severe infestations being noted.

Loganberry Beetle (*Byturus tomentosus*). A number of enquiries have again been received regarding this pest which continues to affect loganberries and raspberries.

Leaf Hoppers (*Jassidae*). Leaf hoppers of the genera *Chlorita* and *Typhlocyba* again caused considerable injury by spotting the leaves of plums, apples, and other fruits. The trouble was generally distributed throughout the Province, but was less serious than during the previous year.

Codlin Moth (*Cydia pomonella*). Codlin moth has been serious throughout the Province, and much damage has been done by a second brood.

Flea-beetle Damage to Cauliflowers and other Brassicae.—Psylliodes chrysocephala has again been serious in the Bristol Market Gardening districts, where no measures against it were taken. Further reference is made to this pest.

Eelworm (*Heterodera schachtii*). Serious cases of damage to potatoes by this eelworm occurred on allotments, near Bristol. Of special interest was a severe attack, by the same eelworm, on sugar beet, near Bristol.

Cutworms (*Agrotis spp.*). There was a noticeable increase in the number of enquiries concerning damage by cutworms during the year. A variety of crops were affected.

Black Fly (*Aphis rumicis*). This aphis has been exceptionally common.

Carrot Fly (*Psila rosae*). This has caused much damage in the Bristol area, particularly to celery. Further reference is made to this pest.

Red Spider. Violets in the Cheddar district have suffered exceptionally severely from attacks of the species *Tetranychus telarius*, in spite of the late date at which the plants became infected.

Apples and plums throughout the Province have been seriously damaged by *Oligonychus ulmi*, trees being badly defoliated in many cases.

This species has also been the cause of widespread damage of a serious character to strawberries throughout the Province. There seems little doubt that red spider can cause a " small-leaf " type of plant similar to that caused by the aphis (*Capitophorus fragariae*).

The seriousness of the attacks of red spider during the past year, are in all probability due to the dry periods which have been experienced.

Many enquiries have been received concerning tar-distillate washes, oil sprays and insecticide dusts, in addition to the usual large number of letters regarding strawberries. Enquiries regarding strawberries were of the usual varied nature.

Agricultural Shows.

Exhibits were staged at the following Agricultural Shows :—

The Bath and West and Southern Counties Agricultural Show, Dorchester.
The Three Counties Agricultural Show, Hereford.
The Wiltshire County Agricultural Show, Salisbury.
The Devon County Agricultural Show, Plymouth.

Exhibits illustrating the work carried out on strawberries were again a special feature of the above exhibits.

Lectures.—The following lectures were given during the year :—

October, 1927 ..	To the Canterbury Branch of the Kent National Farmers' Union. "Strawberry Research at Long Ashton."
November 27th, 1927.	To the Pershore Progress Club. "Tar-Distillate Washes."
November, 1927 ..	To the Maidstone Branch of the Kent National Farmers' Union. "Strawberry Research at Long Ashton."
January 23rd, 1928...	To the Ash and District (Kent) Fruit-Growers' Association "Strawberry Troubles."
January 25th, 1928...	At Dartford, Kent. "Strawberry Troubles."
September 27th, 1928.	To the Agricultural Meteorological Conference, Meteorological Office, London. "The Effect of Rain following the Application of Tar-Distillate Washes."
October 15th, 1928...	To the Swanwick and District (Hampshire) Fruitgrowers' Association. "Strawberry Troubles."
October 29th, 1928...	To the Sevenoaks Branch of the National Farmers' Union. "Strawberry Troubles."

Field Investigations and Trials carried out in the Counties.

Tar-distillate Wash Trials. Three trials were carried out in the Cheltenham district in collaboration with the Research Entomologist. Though designed primarily to supply information as to the relative efficiency of the Long Ashton Tar-distillate spray as a general ovicidal wash, in comparison with a good commercial brand, the centres were specially selected so as to allow of the effect of the washes on Capsid eggs being observed.

The Long Ashton spray proved itself superior to the other wash tested, a commercially economic control against Capsid Bug being obtained with it at 10 per cent strength.

Pear Midge (*Contarinia pyrivora*). In collaboration with the Research Entomologist, experiments on the control of this pest have been carried out in two counties. The distribution of the experiments was as follows :—

Gloucester	3
Worcester	2

The treatments tried are shown below :—

(1) Soil treatment with Calcium Cyanide.
(2) Treatment of the soil with Tar-distillate washes.
(3) Spraying with Nicotine washes.

The above treatments have been carried out both in grass and in arable orchards. Excellent results have been obtained with the calcium cyanide treatment, and by spraying with nicotine washes. Satisfactory results have not yet been obtained with regard to soil treatment with tar-distillate washes.

Control of Woolly Aphis by Means of Aphelinus mali. A large scale infection of Woolly Aphis by means of the introduced parasite *Aphelinus mali* has been made in an orchard in Worcestershire by arrangement with the Ministry of Agriculture. The parasite has so far failed to establish itself.

Strawberry Problems.

(*a*) *General.* Further visits have been made in connection with the systematic survey of the strawberry growing districts, in order to obtain further information with regard to certain points.

(*b*) *Strawberry Aphis.* The demonstration plots of the variety Royal Sovereign, which were put down in the Tamar Valley, at Botley (Southampton area) and at Wisbech, are being continued. It is necessary to continue these for several years in order to demonstrate fully the course of the attack of aphis and the condition of the plants up to the time of death.

A field experiment on the control of strawberry aphis by the use of nicotine and other contact dusts was carried out in Worcestershire. Eighteen samples were tested, and preliminary results of an interesting nature were obtained. While some of the dusts gave poor results, the majority were satisfactory, a few being of exceptional merit. An account of the experiment will appear later.

(*c*) *Red Spider.* A preliminary survey of the incidence of Red Spider in several strawberry districts has been made as a preliminary to further work on this pest during the coming season. The attack this year has demonstrated the fact that red spider is of great importance as a strawberry pest.

Field and Laboratory Work at Long Ashton.

Strawberry Aphis (*Capitophorus fragariae*). The records taken on nearly 5,000 plants over a period of years have been completed. It is now abundantly clear that the so-called "patch" type of plant is most commonly the final stage of aphis attack, prior to the death of the plant. It has also been established that after the autumn in which a healthy plant develops "small leaf" as the result of an attack of aphis, the aphids largely cease to feed on the plant, but migrate to healthy plants. The above fact explains the extreme rapidity of the spread of the pest. All the information concerning Strawberry Aphis so far unpublished is now in course of preparation for the press.

Strawberry Eelworm (*Aphelenchus Fragariae*). The infection experiments with *Aphelenchus fragariae*, and the detailed examination of plants and their runners, over a period, in order to ascertain the number and distribution of eelworm have been concluded. The facts obtained in these experiments and examinations strongly

support the view that eelworm is not the cause of "red plant." Further work on the physiological aspect of the problem will be carried out in collaboration with the Plant Physiologist.

Economic Mycology.

Number of Enquiries.

The number of enquiries dealt with by post during the year was 154. Numerous enquiries were also made by telephone, and by visitors to the Research Station.

Source of Enquiries.

Gloucester (including Bristol)	40
Hereford	19
Somerset	40
Wiltshire	11
Worcester	28
Other Counties	16
	154

Fifteen enquiries were from County Authorities in the Province.

Visits.

117 Visits were paid to farmers and fruit growers during the period under review.

General Observations.

The weather during the period under review was marked by :— (1) the excessively wet winter of 1927, following a wet summer ; (2) a cold April ; (3) a warm and dry summer. Each of these factors had marked effects on the incidence of fungus diseases. For example, the water logging of the soil during the winter favoured the attacks of root-attacking fungi, such as *Armillaria mellea* ; the cold spring gave an opportunity for the development of blossom-infecting fungi (*e.g. Monilia fructigena*) ; while the dry summer checked the majority of fruit diseases, such as apple scab, but in some soils brought about drought conditions adverse to shallow-rooting plants. Points of special interest concerning plant diseases during the season are given below.

Apple Mildew. Primary outbreaks of this disease were severe, but after June the attacks were not apparent. In nursery stock the fungus showed a recurrence of activity in the autumn. Particulars of spraying trials are given elsewhere.

Apple and Pear Scab. Following a bad "scab year" (1927), the young wood was seen to be very badly infected in the spring. The generally dry conditions during the summer, however, did not permit of a serious outbreak, and the disease was easily kept in check by spraying. Favourable reports were received from the Vale of Evesham of control by sulphur dusts. In unsprayed orchards a moderate amount of scab developed after the wet period in August.

Fruit Rots. Excessive wasp damage in 1928 led to frequent infection by *Monilia fructigena* and *M.cinerea*, but there was no extensive outbreak of brown rot as in the wet summer of 1927. At Long Ashton, the mycelium of these two species was found developing vigorously on plums, in a cold store, at 1° C.

Fusicladium cerasi was recorded on fruits of "Yellow Egg" plum, in October, 1927, and a powdery mildew (? *Podosphaera oxyacantha*, var. *tridactyla*) on fruits of the same variety in June, 1928.

Occurrence of Roesleria hypogaea. This fungus has been found at Evesham on dead and dying roots of pear (varieties, Conference and Fertility). The primary cause of death appears to have been poor union, and too deep planting.

Die Back of Stone Fruit. This problem is being studied by the Research Mycologist, as a part of the Soil Survey, in the Vale of Evesham. A serious case of cherry die-back associated with *Cytospora* attack was noted in Worcestershire during August.

Silver Leaf. An example of Silver Leaf on pears has been encountered in Worcestershire. The trees were of the variety Hazel top-worked with Conference. Five trees out of twenty three were attacked, three of which had died. The disease was characterised by a marked wilting of the leaves in addition to silvering, and it was reported that the course of the disease was much more rapid in pears than in plums. The trunks of the three trees which had died showed abundant fructifications of *Stereum purpureum.*

Pear Blossom Bacillus. A mild attack was noted near Pershore, during April, on the variety Conference.

Raspberry Diseases. Dying out of raspberry canes has been common in the Province during the summer. The primary cause appears to have been drought, acting on roots weakened by the water-logging of the previous winter. In many instances, death of the canes was hastened by attacks of spur blight (*Didymella applanata*).

Powdery mildew of the raspberry was again recorded in the Long Ashton plantations. The varieties affected, and their relative susceptibilities, were as in 1927.

Currant Leaf Spot (*Pseudopeziza ribis*). This disease continues to be one of the major problems of the black currant grower. The fungus has also been found on red currants and on gooseberries, but the evidence at present is that the strain on black currants is distinct. Three spraying trials were carried out at Long Ashton in 1928, and, as a result, it was found that a Bordeaux spray applied immediately after picking was completely effective in preventing defoliation.

American Gooseberry Mildew. Treatment with sulphur dusts is now becoming general in large plantations, and has given good results where the applications have been made sufficiently early. Where no treatment has been given, as in many gardens throughout the Province, heavy losses have occurred. At Long Ashton a serious outbreak in September on rooted cuttings was satisfactorily controlled by dusting with sulphur.

Diseases Caused by Botrytis. An unusual type of *Botrytis* attack on gooseberry was found in the Long Ashton plantations during May. The fungus attacked and killed back the young shoots, causing serious injury, in many cases having apparently entered by the leaf stalk. After all the diseased material had been cut out there was no recurrence of the attack. Similar symptoms have been found on tender shoots of *Cupressus macrocarpa*. On this host, the *Botrytis* attack was most in evidence during November.

A leaf spot, stem and flower rot of pelargonium due to the same fungus was recorded in February. Overcrowding and poor lighting were predisposing causes favourable to the disease. *Botrytis* diseases of Brassicae have been frequently observed throughout the Province. An isolated example of die-back of black currant, due to a *Botrytis* was noted at Long Ashton in March. A leaf spot of rhubarb and a rose twig canker associated with forms of this genus were also under observation. A collection of *Botrytis* cultures from various plants has been got together for purposes of comparison.

Collar Rots. Collar rots due to *Armillaria mellea* have been very frequently encountered during the year. In addition to its occurrence on apple, this fungus has been found killing medlar, black currant, willow, tulip tree, nectarine, walnut and redwood.

Diseases of Hops.

(1) *Downy Mildew.* In view of the prevalence of downy mildew (*Pseudoperonospora Humuli*) last year in the hop areas of the Province, a search was made for any possible outbreaks. A specimen of bines affected with the mildew was sent in from Tenbury, Worcestershire, in the early part of June, but no other case was observed, despite persistent rumours of the presence of the disease. The dry weather in the early summer was probably responsible for its practical disappearance.

(2) *Nettlehead.* The so-called nettlehead disease is prevalent in several hop-yards in the Hereford district, mainly on the variety Fuggles. Somewhat circular areas are affected. The symptoms are a chlorotic appearance of the leaves, which tend to be rolled upwards, extreme shortening of the nodes, and a tendency for the shoots to come off the wires. The disease is usually associated with a heavy aphid infestation, which suggests that it may belong to the virus group, as has been already pointed out by C. A. W. Duffield ("Nettlehead in Hops," Ann. Appl. Biol. XII, 1925, p. 536). The Adviser hopes to investigate the disease further in co-operation with Wye College.

(3) *Split-leaf.* The disease referred to as " split-leaf " by Salmon and Ware (Journ. S.E.Agr.Coll., Wye, Kent, No. 25, 1928, p. 142), has been noted in the Hereford district. It is characterised by a curious crinkling and splitting of the bases of the leaves. The leaves at the base of the plants are frequently normal, the disease appearing on the eighth or ninth shoot up the bine, and becoming progressively more severe up the plant.

(4) *Mosaic.* A case of an apparently infectious mosaic was noted on the variety Fuggles, in Worcestershire.

Potato Diseases. The potato crop was generally free from blight until the beginning of September, when a severe and widespread attack developed. A serious failure of potatoes due to a combination of *Rhizoctonia* and eelworm attack (*Heterodera schachtii*) was recorded in June from allotments on the outskirts of Bristol.

Root Rot of Dwarf Beans. A root rot of dwarf beans was prevalent in the fields around Evesham during June and July, practically every plant being affected. The main stem and tap root are affected, the lesions being reddish in colour and confined to the cortex. The plants are chlorotic and stunted and the yield is poor. A *Fusarium* was isolated from the lesions, and its pathogenicity proved by inoculation. The symptoms of the disease in the field, and the cultural and morphological characteristics of the fungus, much resemble those of the " dry root rot " described from the United States, and caused by *Fusarium Martii* var. *phaseoli.* (" The dry root rot of the Bean," Walter H. Burkholder, Cornell Univ. Agr. Expt. Stn. Memoir 26, June, 1919).

Bacterial Disease of Field Peas. This disease was found to be present in the Evesham district during the early summer. Water-soaked lesions, which subsequently become brown or black, occur at the bases of the stems and on the leaves and pods. The effect of the stem lesions is to cause the plants to die off prematurely. Growers state that it is practically impossible to grow wrinkled varieties successfully. Bacteria were isolated and their pathogenicity proved by inoculation. The disease resembles that caused by *Pseudomonas pisi* Sackett recorded from the United States, and described in " A Bacterial Stem Blight of Field and Garden Peas," by Walter G. Sackett (Colorado Agr. Coll. Agr. Expt. Stn., Bull. 218, April, 1916).

Colletotrichum Root Disease. A case of severe infection with the fungus *Colletotrichum atramentarium* occurred on tomatoes in certain glasshouses in Somerset. The disease, described by Bewley and Shearn (Ann. Appl. Biol., XI, 1924, p. 244), is characterised by a peculiar corky condition of the roots from which the cortex subsequently comes away easily, disclosing, when the plant has dried off, the minute black sclerotia of the fungus. The disease imposes a check on the growth of the plants, resulting in a considerable reduction in the crop of fruit.

Miscellaneous.

The following diseases have also been under observation :—

Grey bulb rot of tulips (*Sclerotium tuliparum*), tomato foot rot (*Phytophthora sp.*), cherry blossom wilt (*Monilia cinerea*), wall-flower diseases (*Peronospora parasitica* and *Botrytis cinerea*), and leaf spot and twig die-back of plane (*Gnomonia veneta*).

The root rot of pyrethrum, common during 1927, has not developed during 1928, and is thought to have been due principally to water logging.

Special Investigations.

Bunt Prevention Trials. At the request of the Ministry of Agriculture these trials were again carried out in 1927-28, and a double series of plots was laid down at Long Ashton. The full account of these trials is given elsewhere.

Apple Mildew Spraying Trials. Attempts have been made to control apple mildew by liver of sulphur sprays, made up with " Agral " as a spreader. Satisfactory control was not obtained by this method.

Asparagus Diseases. The investigation of the diseases of asparagus, prevalent in the Evesham area, commenced by Dr. Nattrass, has been continued. It is apparent that formerly the fungus *Rhizoctonia Crocorum* was not infrequent on the roots of the plants, bringing about rapid dying off (see Barker and Gimingham, Long Ashton Rept., 1916, pp. 39, 40). Only one case of this disease was observed in the period under review, and that was confined to an area a few yards in circumference. The disease now most troublesome is characterised by a softening of areas of the roots, which subsequently become hollow, with the result that, in about five years from the time of planting, the shoots become spindly and useless from a commercial point of view. A species of *Fusarium* is associated with this condition (cf. Nattrass R. M., Long Ashton Rept., 1926, p. 142).

Willow Diseases.

(1) *Rust.* Observations are being made on the species of *Melampsora* affecting basket willows. *Melampsora* cankers were frequent at the bases of young shoots of varieties of *Salix triandra* in early summer at Long Ashton, and brought about a subsequent infection of the leaves. Only a slight incidence of this disease was noticed in the Somerset basket growing districts. Bordeaux Mixture 4-4-50 gave an appreciable control.

(2) *Physalospora disease.* This disease has been fully reported on by Nattrass (Trans. Brit. Myc. Soc., XIII, 1928, pp. 286-304). Early in June cankers bearing perithecia of this fungus, accompanied by its Gleosporium stage, were found at the extreme bases of the young shoots, the infection having apparently come from the crown. These cankers, by girdling the bases of the stems, often produce wilting and death of the shoots.

In February it was found that *Physalospora* cankers, on golden

willow, were still extending on rods which had been cut the previous September.

(3) *Marssonina disease.* This disease has also been investigated by Dr. Nattrass. In the vicinity of lesions on twigs of *S. purpurea* there were found, in June, minute brown to black leaf-spots which brought about premature yellowing and leaf-fall. *Marssonina* acervuli were present on these spots.

Investigations to be Continued.

In addition to the problems previously described, the following are receiving attention :—

Strawberry Diseases. In view of the similarity of " Red Plant " of strawberries to " Strawberry Dwarf " prevalent in California (Plakidas, A. G., Phytopathology, 18, No. 5, May, 1928. p. 439), which has been claimed to be transmitted by aphids, a study of " red plant " from the virus point of view is being undertaken in co-operation with the Entomological Department.

Plum Rust. A study of the plum rust (*Puccinia Pruni-spinosae*) is being undertaken by Mr. A. H. Quick, a graduate of Bristol University, under the supervision of the Adviser. It is known that this fungus usually overwinters on *Anemone Coronaria*, on which it has its alternate stage, but it has not been definitely ascertained whether uredospores from the plum may not also carry the fungus over the winter in this country. Other species of *Anemone* and of *Thalictrum* and *Eranthis* may also be implicated as alternate hosts. The susceptibility or otherwise of various varieties of plums and possible methods of control are other points which require investigation. The rust was very prevalent throughout the whole area in September, and in some cases brought about considerable leaf-fall.

Shows. Exhibits illustrating fungus diseases of interest to fruit growers and farmers were shown and demonstrated at the Bath and West Show, at Dorchester, and at the Three Counties Show at Hereford.

Willow Growing.

Condition of Crops. The weather conditions of 1928 were favourable to the growth of the basket willow crops, but in the case of the willows in the Somersetshire area yields and quality have been greatly impaired by the severe and prolonged attacks by the beetle—Galerucella. Its ravages were continuous from early summer to September. Short rods with dead tips and side branches have resulted. The damage has been much reduced in the cases where growers have sprayed persistently. Aphis attacks have not been severe, and fungus attacks apparently no more severe than in previous years.

The total number of enquiries answered during the year was 135, distributed as follows :—

Gloucester	7
Hereford	6
Somerset	28
Wiltshire	4
Worcestershire	5
Other Counties	85
	135

The chief enquiries were as follows :—

Treatment in the Cases of Insect and Fungus Attacks.

The severity of the insect attacks led to enquiries being made for methods of treatment. Advice was given on suitable preparations to use and suggestions made on the best methods of application. The results of the work done at Long Ashton during the last three years, in which the Station's Research Officers in Entomology and Mycology have participated, have been most valuable in enabling the best practical advice to be given.

The Planting of New Land.

Assistance has been given to enquirers in advising on the suitability and treatment of land for the Willows, suitable varieties to plant and general management of the crop.

Of the 34 enquiries made under this heading, 15 have been made by members of Women's Institutes desirous of growing rods for their own uses.

The Cultivation of the Cricket Bat Willow.

Owing to scarcity of matured trees, three important bat making firms requested the assistance of the Willow Officer in obtaining suitable material.

The value of bat willow timber is realised, and 24 enquiries were made on matters concerning land suitability, source of supply of sets and management. The number of good sets obtainable in the country, did not satisfy the demands and much undersized material was planted. A grower in Berkshire stated that he could not supply 10,000 sets for which he had received orders.

Other enquiries were made relative to varieties suitable for tying market garden produce and nursery stocks, to methods of growing willows under sewage farm conditions, to methods of preparing rods for market, and regarding manurial treatment.

The Willow Officer has co-operated closely with the Somerset County Council in the work of establishing two variety trial plots in the County. Sets of seven of the varieties selected for trial were supplied from the Trial Beds of the Long Ashton Station.

Lectures.

Three lectures were given as under :—

The County Farm Institute, Moulton, Northampton.
The Women's Institute, Backwell, Somerset.
The District Council Offices, Horsham, Surrey.

Exhibition.

An exhibit of Willows was shown at the Bath and West Agricultural Show, at Dorchester.

REPORT ON THE ADVISORY WORK OF THE CAMPDEN RESEARCH STATION, 1927-1928.

1927. Much of the time of the scientific staff has again been taken up with advisory work, principally with the rapidly developing canning industry, and several visits have been made to canneries where automatic plant has been newly installed. As a result of the experiments carried out at the factory belonging to the Littleton & Badsey Growers Ltd. during 1926, a new automatic canning line was installed by this Society during 1927, and over 500,000 cans were processed and readily sold. The Herefordshire Fruit Co. Ltd., of Hereford, also installed an automatic canning line during the year, and the help of the Research Station was solicited with reference to strengths of sugar syrups for the various fruits, and also for information on processing. Two canning lines were installed by the Cotswold Packing Co., Ltd., at Ashchurch, Glos., and the Research Station helped them to overcome many of the initial difficulties in connection with fruit canning. The advice of the Research Station was also sought by many other canners, and also by can manufacturers and by manufacturers of lacquers for the coating of the inside of fruit cans.

The apple canning plant installed, by arrangement for demonstration purposes, on the premises of the British Fruit Packing Co. Ltd., could not be fully tested in 1926 owing to the shortage of the apple crop in Kent. In 1927, however, there was a very good crop of apples, and members of the Campden staff helped to start up the plant in September, and supplied all the necessary technical information to ensure a satisfactory pack.

At the request of the National Food Canning Council, a report on the strengths of syrup required for fruit canning was prepared and submitted to the Canners' Committee. In connection with this report, samples of our canned products were submitted to canned fruit brokers for critical examination.

A note on the Canning of Mixed Vegetables was also prepared for the above Committee.

At the request of the Ministry of Health, cherries were put down in various strengths of sulphur dioxide solutions in chestnut casks in order to find out the minimum amount of SO_2 necessary to secure their preservation for the manufacture of crystallised and glacé cherries. A report on the subject was submitted to the Ministry concerned.

The total number of enquiries dealt with during the year 1927 amounted to 419, of which 126 were of a commercial nature.

There has been a large demand for popular leaflets dealing with the preservation of fruit, and 3,700 of these were sold during the year.

1928. The outstanding feature of the Advisory work has been a notable increase in the number of enquiries of a commercial nature. Attention to the latter has absorbed so large a part of the time of the limited staff of the Station that the pure research work has suffered considerable interference. Notwithstanding this, important advances have been made on certain technical questions concerned with canning methods.

During the year 312 enquiries have been dealt with, 160 being of a commercial nature.

The enquiries have been of a varied character. One of the most interesting cases was that of samples of canned strawberries with a peculiar " burnt toast " flavour. Almost all the canned strawberries from one cannery were affected, and an examination of the cans, together with an analysis of the contents, showed the presence of a considerable quantity of sulphur. On receipt of the Station's report, the firm made enquiries amongst the growers of the fruit and found that " green sulphur " had been used as a check to strawberry mildew when the plants were in fruit.

The cause of " springers " in canned fruit has also been investigated at the request of certain canners.

The canning of green peas is now receiving more attention than previously. Three large firms have been using the method worked out at Campden for keeping peas green, and all have passed very favourable reports. There have been several enquiries relating to pea canning, and four firms have been canning peas experimentally this season. Representatives of a firm of dry pea packers have visited the Station and they have decided to install plant for canning fresh English peas next season. The Acting Resident Director has addressed the Canners' Committee of the National Food Canning Council on the canning of peas, and as a result of this talk, one canner has increased his acreage of peas from 100 to 300 acres.

Twelve visits have been made to fruit and pea canning factories during the season.

Bottling and canning in the home is still making headway, and some 3,700 leaflets dealing with the preservation of fruit and vegetables have been sold during the fruit season. There has also been a marked increase in the sale of the hand canning machine, the makers having sold 71 machines this season, along with 23,700 cans for use with the machine. Domestic enquiries totalled 85.

REPORT ON THE EDUCATIONAL WORK OF THE CAMPDEN RESEARCH STATION, 1927-1928.

1927. An exhibit of preserved fruit and vegetables was sent to the Imperial Fruit Show in October, and attended by members of the staff. Many enquiries, chiefly relating to fruit canning, were received as a result of the exhibition.

Several Lectures and Demonstrations on canning and bottling were given to Women's Institutes in Gloucestershire and neighbouring counties. The number was not so large as last year owing to the fact that the Gloucestershire and the Warwickshire Federation of Women's Institutes sent students to the Research Station last season to enable them to give demonstrations at their Institutes.

The judging of bottled fruits, jams, etc., was undertaken at exhibitions under the auspices of the Gloucestershire and Warwickshire Federation of Women's Institutes, and also at local Flower Shows. Apart from exhibits which have been loaned to horticultural lecturers and others, exhibitions of bottled and canned fruits were shown at the Bath and West Show and the Three Counties Show, both of which exhibitions resulted in a number of students enrolling for the Courses, and also in the sale of a large number of leaflets.

During the fruit season, five Courses of Instruction were given, the first Course commencing on July 5th, and the last Course ending on September 9th. Fifty-seven students enrolled for the Courses, but seven cancelled for various reasons when it was too late to fill their places, so that the number of students who received instruction was fifty. For the second and fourth Courses a large number of applications had to be refused. Fifty per cent. of the students were teachers or students of domestic science, and the following Domestic Science Colleges were represented either by staff or students :—

The F. L. Calder Domestic Science College, Liverpool.
The Gloucester Domestic Science College, Gloucester.
The Cardiff College of Domestic Arts, Cardiff.
Benidge House Domestic Science College, London.
Battersea Polytechnic Science College, London.
Atholl Crescent Domestic Science College, Edinburgh.

The remaining students were composed of agricultural lecturers and private individuals. The Cheshire School of Agriculture, the Staffordshire Farm Institute, and the Chadacre Farm Institute were represented by members of their respective

staffs, and the Midland College of Agriculture was represented by two students. Of the private students, two were members of a small colony of smallholders in Surrey, who make jam on a fairly large scale for the "Home-made" Departments of well-known firms in London and Bath. Another who came from South Africa was very interested in a scheme to organise instruction in fruit preservation among South African women.

In addition to the ordinary Courses, the students were taken to Worcester, where they had the privilege of seeing the manufacture of cans at Messrs. Williamson & Sons' factory. They also saw the canning of fruit on a large scale at the Vale of Evesham Fruit Canners Ltd., at Badsey, after having canned fruit on a small scale in the Home Kitchen.

1928. The Courses of Instruction were well attended, some 45 students attending. This number could have been exceeded, but eight cancellations at very short notice prevented the full number of places available from being filled. One of the Courses was confined to Teachers of Domestic Science, by arrangement with the Board of Education, and for this there were more applications than vacancies.

The National Federation of Women's Institutes is taking an active interest in the home preservation of fruit and vegetables, and the services of Miss Adams—the Instructress—have been in demand for lectures and demonstrations.

During the period covered by this Report, the judging of bottled fruits, etc., was carried out at the following Produce Shows :—

Northamptonshire	Federation of W.I's.	at	Kettering.
Oxfordshire	„	„	„ Oxford.
Devonshire	„	„	„ Exeter.
Worcestershire	„	„	„ Worcester.
Warwickshire	„	„	„ Warwick.

A marked feature of these Shows was the increased number of exhibits of jams, jellies, and bottled fruits.

During the fruit season, the combined Institutes of South West Gloucestershire organised a one-day Practice Class in Jam-making under the direction of the Demonstrator from Campden. Two demonstrations on home canning were given at Meetings of Young Farmers' Clubs at Evesham and Farringdon (Berks).

A Demonstration, at the request of the Principal, was also given at a Vacation Course for Teachers of Domestic Science at the Shropshire Technical School for Girls, Shrewsbury. Educational exhibits have been sent to several Shows.

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"The Control of American Gooseberry Mildew; Trials with Sulphur in the Bristol Province." (Journal of Ministry of Agriculture, May 1928.)

"The Physalospora Disease of the Basket Willow." (Transactions of the British Mycological Society, Vol. XIII, 1928.)

STANILAND, L. N. and WALTON, C. L.

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SWARBRICK, T.

"Studies in the Physiology of Fruit Trees—II. The Effects of Ringing, Double Ringing and Disbudding upon Starch Content and Cambial Activity in Two-year-old Apple Shoots." (Journal of Pomology and Horticultural Science, Vol. VI, February 1928.)

"Factors Governing Fruit Bud Formation—VIII. The Seasonal elongation growth of Apple Varieties on some Vegetative Root-stocks; and its possible relation to Fruit Bud Formation." (Journal of Pomology and Horticultural Science, Vol. VII, July 1928.)

WALLACE, T.

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